DOCUMENT RESUME

ED 382 462	SE 056 145
TITLE	Undergraduate Course and Curriculum Development Program and Calculus and the Bridge to Calculus Program: 1993 Awards.
INSTITUTION	National Science Foundation, Arlington, VA. Div. of Undergraduate Education.
REPORT NO	NSF-94-110
PUB DATE	94
NOTE	141p.
AVAILABLE FROM	Internet users, pubs@NSF.gov; BITNET users, pubs@NSF; include NSF publication number and title, number of copies, and your name and complete mailing address.
PUB TYPE	Reference Materials - Directories/Catalogs (132)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Demonstration Programs; *Engineering Education; *Federal Aid; Higher Education; *Mathematics Instruction; Science Education; *Science Instruction; *Technology Education; *Undergraduate Study
IDENTIFIERS	*National Science Foundation; *Reform Efforts

ABSTRACT

The Undergraduate Course and Curriculum Development Program of the National Science Foundation supports the development of courses in all disciplines to improve the quality of undergraduate courses and curricula in science, mathematics, engineering, and technology. The purpose of the program in Curriculum Development in Mathematics: Calculus and the Bridge to calculus is to support projects that reform curriculum and instruction in both calculus and the preparation for calculus, and the implementation of previous, successful development efforts. The projects described in this book received awards in 1993, and were selected for their creativity, scientific and educational quality, and potential for utility at multiple institutions and national impact. Funded projects are expected to produce course and curricular materials that will be of national interest and widely disseminated. The main part of the book lists projects in: chemistry, computer science, engineering, geosciences, interdisciplinary, science and humanities, life sciences, mathematics, physics and astronomy, social sciences, and calculus. Also included are a list of 1993 awards by state and institution, an index of project directors, and a list of program directors for 1993. (MKR)

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ED 382 462

AWARDS: 1993

UNDERGRADUATE COURSE AND CURRICULUM DEVELOPMENT PROGRAM

AND

CALCULUS AND THE BRIDGE TO CALCULUS PROGRAM

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SE 056 145

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Division of Undergraduate Education

Undergraduate Course and Curriculum Development Program
and
Curriculum Development in Mathematics: Calculus and the Bridge to Calculus
1993 Awards

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Foreword

The National Science Foundation's Directorate for Education and Human Resources (EHR) is responsible for providing national leadership and support for enhancing the quality of education in science, mathematics and engineering at all levels of the educational system. Within EHR, the Division of Undergraduate Education (DUE) focuses on ensuring that the best possible undergraduate education is provided to meet the Nation's need for high-quality scientists, engineers, mathematicians and technologists, dedicated and able teachers of pre-college science and mathematics, and scientifically literate citizens.

The Undergraduate Course and Curriculum Development (CCD) Program supports the development of courses in all disciplines within the Foundation's mission. Initially, the CCD program is emphasizing reform of the crucial lower division and introductory-level courses. The enormous interest of the academic community during the first three years of the multidisciplinary program clearly reflects a national need and underscores NSF's important leadership role at the undergraduate level.

The purpose of the program in Curriculum Development in Mathematics: Calculus and the Bridge to Calculus is to support projects that reform curriculum and instruction in both calculus and the preparation for calculus, and the implementation of previous, succesful development efforts. Through the Calculus program NSF has responded to the clear need to improve the teaching of calculus and preparation for calculus, which has been expressed within the mathematics community.

The projects described in this book received awards in FY 1993, and were selected for their creativity, scientific and educational quality, and potential for utility at multiple institutions and national impact. We are proud of these projects and hope that they will be of interest to science, mathematics and engineering faculty at all U.S colleges and Universities

Luther Williams
NSF Assistant Director
for Education and Human Resources

NATIONAL SCIENCE FOUNDATION

UNDERGRADUATE COURSE AND CURRICULUM DEVELOPMENT

INTRODUCTION

Overview

The purpose of the Course and Curriculum Development (CCD) Program is to improve the quality of undergraduate courses and curricula in science, mathematics, engineering and technology. The current priorities of the program are to encourage the development of multi- and interdisciplinary courses, which will better prepare students for the scientific and technical environment of the future, and to encourage faculty in science, mathematics and engineering departments to take leadership in developing educational experiences that enhance the competence of prospective teachers and encourage students to pursue careers in elementary, secondary and post-secondary teaching. The majority of funds continue to support projects that address introductory-level courses, curricula and laboratories, especially those that are interdisciplinary and that address the needs of future teachers. The program also considers proposals that address courses for upper-level students. The program seeks to influence the academic culture, by encouraging a greater number of talented faculty to devote creative energy to improving undergraduate classroom and laboratory instruction.

Summary of Awards

Course and Curriculum Development

The awards made in fiscal year 1993 indicate that significant steps were taken in achieving the program's goals. Eighty-two new projects were selected for funding in 28 states, from 414 proposals submitted. Funding decisions were based on the reviews of eminently qualified panelists. Funded projects are expected to produce course and curricular materials that will be of national interest and widely disseminated.

Several awards are particularly notable in that they proposed to experiment with innovative approaches to facilitating student learning or to adapt from one discipline innovative approaches explored in another. Examples include the fostering of cooperative learning or promoting interaction among students rather than relying primarily on interaction between a faculty member and many students. Harvard University is using peer teaching in introductory physics courses by having students persuade their neighbors of the correctness of their answers to questions posed during lectures; Indiana University is developing Socratic-Dialog-Inducing laboratories designed to engage students interactively to challenge incorrect perceptions; Lord Fairfax Community College (VA) is adapting Workshop Physics to the community college environment, which was developed at Dickinson College.

Computers continue to be employed in innovative ways. For example, projects in oceanography and geology at the University of California at Santa Barbara and SUNY Buffalo, respectively, are making use of computer technology for simulation and visualization as well as data analysis; Talladega College (AL) is challenging the creativity of high aptitude students by encouraging them to design their own chemistry experiments using computer interfaces to a variety of laboratory equipment; the University of North Texas is trying to instill in computer programmers the skills of eliciting software requirements in a collaborative (real-life) setting; an economics course being developed at the University of Missouri-Saint Louis provides specific exercises on numeric and computer analysis; a laboratory approach to introductory differential geometry is being developed at Brown University that uses hypertext tools for interaction and response, and computer graphics to enhance the visualization experience.

In several project topics of current interest to the research community are being incorporated into introductory-level courses. At the University of Wisconsin, for example, a materials-oriented general chemistry course is being developed that involves innovative approaches to learning based on solid materials such as polymers, semiconductors, metals, and ceramics.

Some notable projects involve significant collaboration among several types of institutions. Portland State University (OR) in collaboration with Portland area community colleges is beginning a long-term, massive curriculum revision defining Science as a Liberal Art. The project brings together working groups of faculty from all of the scientific disciplines and all of the area colleges (2-year and 4-year) to define the basic concepts, evaluate cognitive research, and develop courses to be taught in the many different settings. Northern Arizona University and three partner community colleges are experimentally determining which of several curricular reform plans work best in community colleges and large comprehensive universities. This project builds on previous work funded by NSF, Project Kaleidoscope and a Biology Curriculum Framework Study conducted by Biological Sciences Curriculum Study group (BSCS), by evaluating the effect of increased class sizes on programs designed for small liberal arts colleges. A program co-directed by faculty of the New Jersey Institute of Technology and the Camden County College (NJ) involves two consortia comprising 19 community colleges, and relates to manufacturing engineering technology.

The strengths of other projects lie in the special audiences they are targeting, such as prospective teachers, non-science majors, women, minorities and/or persons with disabilities. For example, Clark University's (MA) discovery-based physics emphasizes cooperative learning and open-ended problem solving in the standard introductory sequence, which is taken by science majors and students planning careers as pre-college teachers. At the University of Idaho, senior faculty in the arts and science departments are developing a cross-disciplinary, laboratory-based science course for future teachers, which incorporates the rigor of the scientific and mathematical disciplines with the newest teaching methods. The courses are being developed by the science departments with the participation of Moscow, Idaho public schools and the schools of the Couer d'Alene Reservation. Drexel University (PA) is implementing a curriculum for bioscience majors and prospective pre-college teachers that consists of laboratory modules that lead students to design their own experiments. A collaboration of the College of Engineering and the College of Education at the University of Texas at El Paso is making possible the integration of engineering materials instruction with pre-college teacher preparation activities, with the aim of producing better prepared K-12 science teachers.

Florida Community College (FCC) -Jacksonville is undertaking the development of an ambitious cross-disciplinary technology-intensive integrated curriculum taught by science, mathematics and psychology faculty from the three major campuses of FCC at Jacksonville. The courses, designed to encourage participation in science by a non-traditional student population, use team-teaching strategies in electronic classrooms that allow for simultaneous discovery, exploration, collaborative learning and mentoring at different campus sites. A project at Carlow College (PA) targets adult African-American women with a "Science and Language" course, that combines a science class and a writing class, allowing students to use writing as a tool to learn science. Utah State University is developing a preparatory Computer Science course specifically aimed at women and minorities to attract them into the field and create a supportive environment for continuing their interest in the major. A chemistry project at East Carolina University (NC) is directed at development of laboratory experiences for visually impaired students.

A substantial number of CCD awards in fiscal year 1993 addressed the improvement of courses for non-science majors, and thus are directed at the national "science literacy" problem. The chemistry of materials course at Brandeis University (MA) is an example, in which students will explore fabrication, conservation and authentication of artifacts in cooperation with the National Gallery of Art. The Multicultural Mathematics Project at Grand Valley State University (MI) will develop an introductory, general education course in geometry, which will foster multicultural understanding in its exploration of the cultural aspects of mathematics as reflected in the dwelling places of diverse groups of people.

The NSF, in collaboration with the National Endowment for the Humanities and the U.S. Department of Education's Fund for the Improvement of Post secondary Education, funded projects aimed at improving exchange and interdisciplinary understanding between the sciences and the humanities. Fifteen proposals from 10 states were chosen for awards out of 86 proposals submitted. Funding decisions were made based on reviews by panels that included scholars in both the sciences and humanities.

Awards from this sciences and humanities effort went to projects that go beyond the boundaries of a single discipline and were based on a close collaboration of faculty in the sciences and the humanities with the potential for replication and leadership at the national level. Dartmouth College (NH), for example, is developing courses on assisted reproduction for a new core curriculum that will be taught by faculty with expertise in reproductive biology, psychology, moral philosophy, religious studies and women's studies; Occidental College (CA) is developing a course pertaining to the U.S.-Mexico border; Trenton State College (NJ) is developing a course to provide students with a framework for understanding how scientific and technological innovation affects society; and the University of Oklahoma is enhancing environmental literacy through capstone courses that encourage students to apply their discipline-based knowledge to the solution of practical environmental problems in their own community.

Calculus and the Bridge to Calculus

As part of the National Science Foundation (NSF) effort to provide leadership and support to improve science, mathematics, engineering, and technology education, twenty-six grants totalling $3.5 million were awarded in FY 1993 to strengthen calculus and the preparation for calculus instruction. Of these 25 grants, 14 were new awards and 11 were continuation awards.

Commenting on the awards, Luther Williams, NSF Assistant Director for Education and Human Resources, said: "The effectiveness of calculus instruction has a central role in determining the participation level of individuals in a scientifically and technologically sophisticated society. Through the Undergraduate Curriculum Development in Mathematics: Calculus and the Bridge to Calculus Program, NSF is supporting national efforts to improve the learning of calculus, thereby opening an important gateway into the undergraduate science, mathematics, engineering, and technology curriculum."

The purpose of the program is to foster improvement in the quality of calculus instruction on a national scale. This objective is being achieved through projects that develop effective instructional strategies, incorporate extensive problem solving activities, introduce numerical, graphical, and symbol manipulating computer and calculator systems, model realistic applied problems from the physical and social sciences, and provide wide-spread dissemination and large-scale implementation.

Awards were made to include the spectrum of educational institutions involved in calculus instruction; namely, universities, two-year colleges, four-year colleges, and secondary schools. These awards fall into two major categories: 1) adaptation, refinement, and implementation, and 2) curriculum development. Curriculum development projects are underway at several institutions, many of which involve a coalition of institutions: Boston University (MA), Bowdoin College (ME), Duke University (NC), Harvard University (MA), Rose Hulman Institute of Technology (IN), Sam Houston State University (TX), SUNY Dutchess Community College, University of Connecticut, University of Illinois - Urbana, and University of Massachusetts - Amherst.

Major dissemination and implementation projects were also awarded to several institutions. Evergreen State University (WA), Howard University (DC), Maricopa County Community County District (AZ), University of Arizona, and University of Kentucky are leading large coalition activities to adapt and implement approaches developed at these and other institutions. North Carolina State University, SUNY Stony Brook, University of Iowa, University of Pennsylvania, University of Pittsburgh, and University of Michigan - Ann Arbor are implementing full scale reformed approaches to calculus instruction, providing models for large state universities. The program is managed by the Division of Undergraduate Education in cooperation with other divisions in the Directorate for Education and Human Resources and the Division of Mathematical Sciences.

PROJECT DESCRIPTIONS: COURSE AND CURRICULUM DEVELOPMENT

CHEMISTRY

Development of a Materials-Oriented General Chemistry Course

Arthur B. Ellis	DUE-9254107
University of Wisconsin-Stevens Point	FY1993 $ 700,000
Madison, WI 53706	Chemistry

A materials-oriented approach to chemistry is being developed through the preparation of a book, entitled "Teaching General Chemistry: A Materials Science Companion," by an ad hoc committee of two dozen leading chemistry researchers and teachers. Consisting of text, problem sets, model kits, software, videotapes, demonstration and laboratory experiments, the "Companion" is scheduled for publication by the American Chemical Society in the fall of 1993. The "Companion" demonstrates how virtually every topic typically covered in introductory chemistry courses can be illustrated with solids such as semiconductors, metals, superconductors, polymers and ceramics. The project focuses both on innovation - the completion of material for the "Companion" - and on change - the implementation of a national strategy for assimilating materials chemistry into introductory chemistry courses. Strategies for effecting change include national testing of materials from the "Companion" at over two dozen volunteering college test sites (more than 15,000 students; over 200 teaching assistants); development of modules based on the "Companion" and their use in workshops for college and pre-college teachers; and critical evaluation of the instructional materials by teachers and students through direct feedback and measures of student interest and performance. The "Companion" and supporting activities will revitalize general chemistry courses, enhance the scientific literacy of students and teachers, and increase the number and diversity of high-quality students electing to pursue careers as chemists, chemistry teachers, scientists and engineers. Some of the materials in the "Companion" can also be used in other introductory science and engineering courses. The steps involved in organizing and implementing this project will be summarized and disseminated.

Incorporating Polymeric Materials Topics in the Undergraduate Chemistry Core Curriculum

John P. Droske	DUE 9254351
University of Wisconsin-Stevens	FY1993 $170,323
Stevens Point, WI 54481	Chemistry

The project continues efforts to include polymeric materials topics in the undergraduate chemistry core curriculum. Instructional packets and laboratory experiments will be prepared for use by college and university faculty who have little or no prior experience in the polymer area. The project utilizes and extends the organization and infrastructure developed in a related earlier grant. The three regional sites established in the earlier grant (Rennselear Polytechnic Institute, the University of Southern Mississippi, and the University of Wisconsin-Stevens Point) again will host the NSF-POLYED Scholars who are developing polymer curricular materials during summer residencies at these sites. In addition, instructional videotapes will be prepared at the University of Wisconsin-Stevens Point. Regional workshops will be offered at the three regional sites to begin dissemination of the curricular materials developed. The effort also will move beyond general chemistry to include the preparation of polymer curricular materials for the organic sequence. The materials will be field tested and then disseminated widely through the proposed workshops, through publications, and from the POLYED National Information Center for Polymer Education.

Interactive Chemistry Experiments: A Multimedia Approach

Thomas J. Greenbowe DUE-9253985
Iowa State University FY 1993 $88,078
Ames, Iowa 50011 Chemistry

The project involves developing, testing, producing, and distributing four instructional multimedia software modules for instruction in beginning college chemistry courses. A prototype of one interactive experiment has already been developed and tested. Feedback from students using the prototype was sufficiently positive to generalize and extend the approach. Based upon the promise of the prototype, a major college chemistry textbook publisher and a multimedia software company will contribute to the project. The modules incorporate text, Quick Time color movies, PICT still images, voice narration, and animation sequence techniques. The software will be developed for both the Macintosh II family and IBM PC/clone platforms using a color monitor. No special video boards, laser discs, or laser disc players are required to view the digital motion color images. The modules are programmed using Macro Media's "Director", SuperCard, and Swivel 3D software. Each module features four "Chemistry Workbench" experiments and a special patent pending navigation system. By use of point-and-click mouse techniques, students are able to construct and test different chemistry experiments for topics in solutions, kinetics, acid-base equilibria, and electrochemistry. The materials will be tested, evaluated and reviewed by students and chemistry faculty from various colleges and universities.

Development of a Data Acquisition and Data Analysis System for Visually Impaired Chemistry Students

David Lunney
East Carolina University
Greenville, NC 278584353

DUE 9254330
FY1993 $ 171,713
FY1994 $ 85,856
Chemistry

The project is developing software to make computer-aided chemistry experiments more accessible to students who have visual impairments. The software is to run on an ordinary personal computer equipped with adapted outputs (synthetic speech, electronic music, and enlarged text and graphics). Experimental data is acquired through a modular data acquisition subsystem designed for use in educational laboratories. Experiments for which software is being developed include the instrumental methods commonly used in lower level chemistry courses, and the software includes a data analysis package which enables visually impaired students to perform extensive analysis on data acquired with the system. The system and its software will be usable at any educational level where instrumental measurements are performed, and should be readily adaptable to disciplines other than chemistry.

The Chemistry of Art for Non-Scientists

Michael Henchman
Brandeis University
Waltham, MA 02254

DUE 9254291
FY1993 $ 73,689
FY1994 $ 60,447
Chemistry

A chemistry course for non-science majors which focuses on the chemistry of art is being developed. This course - essentially a materials science course on the fabrication, examination, conservation and authentication of artifacts, is an effective and attractive way of teaching science to non-scientists. At present two factors limit the course at Brandeis and its adaptation elsewhere, the lack of a suitable text and the difficulty of obtaining the necessary scientific data in a suitable form for teaching (e.g. the scientific data for assessing the restoration of the Sistine Chapel ceiling). The proposal has four components: (i) development of a scientific text, limited to relevant topics treated in some depth, (ii) development, as a pilot project, of a teaching laser disc holding all the scientific and conservation data needed to investigate a famous and problematic artwork, The Feast of the Gods (in collaboration with the National Gallery of Art in Washington), (iii) the further development of the successful laboratory component of the course, by introducing chemical microscopy for pigment and fiber characterization, and (iv) the external evaluation of the educational effectiveness of the materials developed.

Using Computers to Challenge High Aptitude Intellect/Stimulate Creativity

Charlie M. Stinson	DUE-9254015
Talladega College	FY1993 $ 63,750
Talladega, AL 35160	Chemistry

The objective of this project is to challenge our high aptitude students through the use of computers to stimulate their creativity as will be manifested in the production of videos discs, cassettes, and other presentations and publications which will be used as pedagogical tools in the further improvement of our instructional program. This will be accomplished through the use of Interactive Videodisk Laboratory. Experiences of this type will enable students to learn chemistry while being creative.

Devising a More Effective Approach to the Study of General Chemistry

David H. Smith, David J. Clevette	DUE 9254245
Doane College	FY1993 $ 99,457
Crete, NE 68333	Chemistry

The content and pedagogy of the General Chemistry course for science majors is being revised to substantially reduce the importance of the lecture by utilizing small group cooperative learning procedures. A renewed emphasis on descriptive chemistry, a reduction in the extent of the mathematical treatment of chemical concepts and the need for students to solve problems that require them to integrate material from previous studies are hallmarks of the new course sequence.

Visualization of the Abstract in General Chemistry

Richard A. Paselk, Mervin P. Hanson	DUE-9156028
Richard L. Harper, John B. Russell	FY1993 $ 103,984
Humboldt State University	FY1994 $ 100,607
Arcata, CA 95521	Chemistry

This project is developing and extending computer-based education that enables students to visualize abstract aspects of general chemistry. The software addresses a real learning problem, that of making the transition from two to three-dimensional representations of objects and models. Existing physical models of adequate sophistication are helpful, but they take laboratory time and space, and do not allow views of interior details, nor transitions between views. In problem solving, therefore, we focus on mathematical/physical intuition instead of the application of particular algorithms. We help the students to make connections between physical reality and mathematical expressions. The computer can show both the exterior of a model and make a seamless transition between exterior and interior views, including various intermediate states. To assure the effectiveness of such simulations, we use sophisticated graphics, sound, and responsive quasi-tactile interaction to engage the students fully in the learning experience. We are first completing a module on bonding, to be followed by modules on gas laws, crystal structures, and solids.

Instructor's Reference Manual for Discovery Chemistry

Robert W. Ricci, Mauri A. Ditzler,
Paul D. McMaster, Richard S. Herrick,
Ronald M. Jarret
Holy Cross College
Worcester, MA 01610

DUE 9254016
FY1993 $ 143,000
Chemistry

An Instructor's Reference Manual is being prepared that will provide information necessary for the efficient adoption of our Discovery Program. This curriculum addresses the concern for teaching students content in the laboratory while still focusing on the process of discovery. A four-course introductory sequence is founded on laboratory exercises in which the students work individually and cooperatively to discover for themselves many of the basic principles of modern chemistry. The essence of the approach is to have students "Discover" the basic concepts by participating directly in the process that is chemistry. Thirty discovery experiments have been integrated into the curriculum. This project is producing a manual that documents instructional methodologies that have been successful with a variety of different discovery exercises drawn from the program, and that also includes an extensive information base for each of the discovery exercises.

Addressing Software Development Skills in a Curriculum Focusing on the Science of Computing

David Cordes, Allen Parrish
University of Alabama
Tuscaloosa, AL 35487-0290

DUE-9254116
FY1993 $ 40,241
Computer Science

This project focuses on techniques that can be integrated into an existing computer science curriculum (that places its emphasis on the science of computing) to ensure the production of competent software developers.

In particular, emphasis is placed on the development of software engineers that can function in an environment of large-scale applications, where emphasis is placed on maintainability, re-use and reliability.

During the student's first year of the studies, he/she should recognize the importance of 'scaling' up his/her software engineering skills to the point where the student is capable of making a smooth transition from the classroom to industry. This project addresses the first year of the curriculum, developing a framework for the student's software development skills that: promotes the construction of reusable code modules, recognizes the problems associated with the development of non-trivial code, emphasizes the importance of software development tools, and introduces the need for cooperation and teamwork in large applications.

These concepts should be woven into a wide range of modules that span the entire curriculum, starting with the very first modules in the curriculum. This research addresses the concerns listed below within the scope of the first year of a student's studies:

Lack of enforced software standards, inability of students to integrate existing knowledge/science, development of basic re-use principles, and lack of appreciation for "large-scale" software.

This research develops the necessary course materials for the development of software engineering materials to be used in parallel with existing science-based computing courses for CS I and CS II. These materials are utilized in laboratories that exist as co-requisites for the CS I and CS II courses. Within the spectrum of the University of Alabama curriculum, these materials represent the two laboratories CS 116 and CS 125.

The specific materials developed include: A complete course syllabus for each course, sample homework assignments for each course, sample programming assignments for each course and case studies that are relevant for each course.

The bulk of the evaluation regarding this proposal will be in the form of surveys and opinion polls from the faculty and students impacted by the revised laboratory process. This includes both initial and follow-up (long-term) student interviews, skill tests, faculty surveys and student competence evaluations.

The results of this experiment will be made available to the general academic community in a number of ways. First, since the University of Alabama is a member of SURAnet (and thus NSFnet), the modules and curriculum packages developed will be placed on-line and distributed via anonymous to any other site on NSFnet that desires the information. Second, the results of this research will be presented to the public through both conferences and journals.

Scientific Visualization

T. K. Alameldin	DUE-9254357
California State University Fresno	FY1993 $ 94,776
Fresno, CA 93740	Computer Science

The project in scientific visualization will enhance undergraduate courses in science, mathematics, and engineering. It will also improve the education of undergraduates who plan to pursue a career in teaching science and mathematics at the pre-college and college level. Students will learn about using visualization as a tool for discovery and understanding complex phenomena. In addition, they will also learn about state-of-the-art visualization techniques that allow scientists and engineers to examine huge amounts of data with higher efficiency and greater comprehension. Finally, students will be provided with hands-on experience of software packages that are widely used in the field. the project injects a component into our curriculum that heretofore has not been widely applied.

A Preparatory Course for Computer Science

Vicki H. Allan, Mary Veronica Kolesar	DUE 9254186
Utah State University	FY1993 $ 74,993
Logan, UT 84322	Computer Science

The first course in computer science is overwhelmingly populated by students from outside the discipline. A high dropout rate as well as a low rate of successful completion of the course indicates a need for a new approach. Poor retention in the following classes and extremely low numbers of women and minorities point to the need for better preparation. We are developing a preparatory course to address these concerns that would cover problem solving, some basic mathematics, and computer use.

Goals include: (1) improve the success rate for incoming computer science majors, (2) Serve as a "magnet" course to attract new majors, (3) Improve the problem solving skills and increase awareness of computer science as a discipline among the general student population, (4) Give a more accurate introduction to computer science as a discipline and 5) Attract women to computer science.

The PIs propose to increase the number of women in the course by 1) emphasizing the mathematical aspect of computer science, where many women excel, 2) present gender-neutral problems, 3) create gender-neutral software, 4) capitalize on existing interest, 5) use study groups, 6) create a supportive environment, 7) use software packages to allow the user to do something useful in a short amount of time, and 8) create a support system in the form of study groups.

This class gives students a firm foundation in the mathematical and problem-solving skills needed for success in this and subsequent classes, as well as gives them a better understanding of what computer science is, i.e., there is more to computer science than programming. By motivating learning through a "recreational" approach to the introduction of mathematical and computer science concepts, the class will attempt to make learning "fun" and to minimize the typical frustrations encountered. The text "Mathematics: Problem Solving through Recreational Mathematics" by Averbach and Chein will be revised to include computer science topics development of cooperative work habits will be encouraged through the use of study groups. Proposed laboratory exercises will allow students to apply the concepts presented and to investigate them more fully.

The Innovative Use of Software in Introductory Computer Programming

Jeffrey L. Popyack, Nira Herrmann	DUE 9254013
Drexel University	FY1993 $ 25,000
Philadelphia, PA 19104	Computer Science

We are developing a new approach for teaching introduction to computing courses, tailored to the needs of students in different curricula. This approach is based on the following precepts:

1. There is a strong need for students in all curricula to understand the concepts of programming a computer, particularly in the sciences and engineering fields.
2. It may no longer be necessary for students in many majors to know how to write programs in traditional block-structured languages (such as Pascal).
3. There is a wealth of software in wide use today which allows the user to write programs in specialized built-in macro languages.
4. Teaching programming concepts through the use of powerful, user-friendly software with programmable features allows the user to write programs immediately which produce nontrivial results. This provides stronger motivation to learn programming than traditional approaches.

Moreover, the essential concepts of computer programming, (such as variable, branching, iteration, etc.) can be readily illustrated and implemented using the sophisticated features of a variety of commonly available software packages, such as word processors, spreadsheets, and databases. The main intention of our approach is to teach programming concepts and techniques, not simply how to use software. Students will be exposed to the kinds of functionality common to all languages, thus facilitating the learning of a general purpose language or new, innovative software they will need for pursuing both their education and their careers in science, engineering, or teaching.

This project focuses on two courses, a general introduction to scientific and statistical programming for science majors and an introductory programming course for computer science majors. It focuses on developing a set of modules to illustrate the programming concepts exhibited by various pieces of software in the Drexel "bundle" which each freshman obtains. In addition to the modules, examples and exercises and being created in the two subject matter areas.

Gateway Labs for a Problem Solving Course

Greg W. Scragg	DUE 9254252
SUNY Geneseo	FY1993 $ 83,919
Geneseo, NY 14454	Computer Science

We claim that short hands-on laboratories make text books obsolete for many purposes. This is particularly true for those topics which are largely implementation-dependent or "how to" topics, or topics that deal with purely representational aspects of material. This material is better presented in small interactive modules, which we call gateway labs. The name gateway was used in part because these labs share some of the properties of both open and closed labs: they are open because the student works independently, but the tasks comprise closed-end introductions, which can be much shorter than either of the two more common formats, open or closed labs. We claim students should receive the bulk of their "how to" instruction through direct hands-on interaction with gateway labs. The lectures, the text, and the traditional labs can, thus, be devoted to the more intellectual aspects of the course, such as problem solving. We believe gateways should be implemented as a coordinated set of as the principal means of instruction in the use of specific software tools. Gateway labs will be assigned regularly and frequently, just as most courses currently employ reading assignments. We expect roughly as many gateway labs as there are lectures. Thus, a full course will incorporate 30 to 40 specific modules.

We presently incorporate several gateway labs in our primary course for non-majors, "Problem Solving with Computers," a problem-solving course, in which the actual use of computer tools is subordinate to the generalized problem-solving techniques. Although we focus on problem solving, students must still have experience in the use of specific tools. Such experience is best gained through laboratories, but we want to use our traditional-format labs for problem-solving experiences.

This proposal should attract more women, minorities and prospective teachers since the student body has 68% women and 29% preparing to be teachers. In addition the institution has increased the number of minority students from 2% ten years ago to 17% in the current freshman class.

Development of an Undergraduate Major in Information Technology

Kevin Donaghy, Michael Yacci, Peter H. Lutz	DUE 9254160
Rochester Institute of Technology	FY1993 $ 77,998
Rochester, NY 14623	Computer Science

The goal of this project is to develop an undergraduate major in Information Technology that includes courses in telecommunications, information storage and organization, human-computer interaction, technology transfer, and computer programming. The curriculum development efforts of fifteen faculty from the Information Technology and Computer Science departments will be coordinated by the three principal investigators. Team members will participate in a workshop in summer 1993, work individually and in small groups throughout the year on construction and evaluation of course materials, and host a national workshop on undergraduate Information Technology in fall 1994.

Already rich in information expertise, RIT intends to become a leader in this emerging field. The results of our curriculum development efforts will be shared through professional meetings and publications. We also hope to initiate a professional society in Information Technology so that curricular and technical developments can be disseminated nationally.

An Integrated Approach to Teaching the Languages of Programming and Mathematics in the Computer Science Curriculum

Edward Conjura, Ursula Wolz	DUE-9254109
Trenton State College	FY1993 $ 78,604
Trenton, NJ 08625	Computer Science

Computer Science educators are faced with the dilemma that one cannot do computer science well without being a good programmer, nor can one understand the underpinnings of computer science without a strong background in mathematics. The goal of this project is to use the first three courses of the computer science major to make students fluent speakers of mathematics and programming, and to expose them to both functional and imperative language paradigms so that they can effectively learn computer science. Computer Science I and Discrete Mathematics, taken in the first semester, will carefully articulate the strong ties between mathematics and programming through an integrated curriculum, a functional programming language and a shared laboratory. Computer Science, taken during the second semester, will bridge the gap between the mathematical perspective of the first semester and the implementation of an algorithm as a sequence of instructions through an imperative language. All courses will also provide a strong foundation for the computational concepts that are considered in advanced courses. The approach used exposes students to theoretical concepts in mathematics and computer science without having these concepts walled off as abstractions unrelated to applications, and it gives students extensive programming experience without neglecting important theoretical concepts that are the foundations of correctness and the basis for generalization and creative work.

Interdisciplinary, Laboratory-Oriented Course for Computer-Based Problem Solving

Barry L. Kurtz, Gary S. Klein,
Louis E. Roemer, Michael B. O'Neal,
Sam V. Dauzat
Louisiana Tech University
Ruston, LA 71272

DUE-9254317
FY1993 $ 101,833
Computer Science

Most universities require all students to attain some understanding of computing as part of their college experience. Often courses in "computer literacy" are offered to meet this requirement. These courses, as they are currently taught, are often inadequate for a number of reasons. First they tend to present descriptions of what computers can do rather than focus on how people can use computers to solve problems. Also, they concentrate on teaching the syntax of currently popular software packages or programming languages, instead of focusing on the underlying characteristics of these tools. These courses also fail to represent the breadth of the computing sciences. Hence, what is learned tends to be shallow and of short term value.

There is a critical need for a general course, accessible to the average college freshman, that will introduce the underlying principles of computing while stimulating the student's problem solving abilities. The proposed course will meet these objectives. The hear of the approach is to present abstract concepts through the use of computer-based simulations. These simulations will allow students to explore the concepts in a "hands on" manner.

The course is designed to be taught in a single semester and will provide an overview of computer science. Many facets of the discipline will be explored through lecture and the accompanying laboratory exercises. Topics include: common applications, such as spreadsheets, databases, computer aided design, artificial intelligence, and computer graphics; algorithms and the major programming paradigms (functional, procedural, and logical); computer architecture, including machine organization and digital logic; and foundations of computing, including automata theory, Turing machines, and complexity theory.

The course development effort is truly interdisciplinary with faculty from Computer Science, Business Administration, Education, Engineering, and Arts and Sciences actively involved in the course design. Evaluation plans call for initial development of the course materials at Louisiana Tech University followed by their use a several other universities. Plans for dissemination include making all courseware developed for this project available via the Internet. The PIs also plan to write an introductory computer science text to facilitate the use of the course materials at other institutions.

The essence of this development is a structured laboratory environment, including both open and closed labs, that is completely integrated with the lectures. It is the PIs belief that abstract concepts can be taught to, and understood by, students with limited math backgrounds if provided hands-on laboratory activities that cover the basic concepts. Students completing the course are expected to have a much greater appreciation for the computing sciences and many may be inspired to pursue careers in this area.

Mathematical Problem Solving for Introductory Computer Science

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SUNY at Stony Brook	FY1993 $ 115,001
Stony Brook, New York, 11794	Computer Science

The objective of the proposed work is to develop a freshman level course, Foundations of Computer Science, in the interface of computer science and mathematics that integrates critical reasoning, problem-solving strategies and discrete mathematics topics with fundamental computer science concepts. Mathematics and computer science educators have observed and commented on the weaknesses of entering college students in the areas of problem solving and mathematical reasoning, skills which are fundamental to computer science and should be a primary focus of a first college level course for computer science majors. The course to be developed emphasizes the importance of mathematics and problem-solving concepts within the context of computer science and its applications. Computer laboratories are an integral component of this philosophy. Hands-on experience acts as a catalyst to reinforce course material, provides motivation for learning and encourages students to be creative, independent thinkers. An added bonus is the wide applicability of such an approach to other mathematically based disciplines.

Our primary objective is to develop and evaluate material which makes it easier for educators to teach mathematically based introductory computer science courses and to integrate these concepts into existing courses. The material to be developed includes guidelines, available resources, annotated notes, problem sets, exam questions and laboratory software and manuals. The material will be disseminated through announcements in mathematics/computer science education journals, meetings, newsletters, electronic bulletin boards and direct mailings. Evaluation of course material using both problem-solving and mathematics pre-tests and post-tests and survey questionnaires can assess the suitability of this approach for introductory computer science and can improve the quality of the material. Evaluation of laboratory material can also significantly improve the quality of supporting courseware and manuals.

The emphasis of most introductory courses in computer science is on programming rather than mathematical foundations and problem-solving. The significance of the proposed work is to develop a model introductory course whose focus is mathematics, problem-solving, critical reasoning, and computer science applications for others to emulate. Evaluation of the impact of this course in the context of the computer science curriculum at Stony Brook will be used to demonstrate the importance of this approach to teaching introductory computer science.

Using a Computer-Supported Cooperative Environment to Teach Computer Science Students Cooperative Skills and Requirements Elicitation

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Denton, Texas 76203

DUE-9254068
FY 1993 $ 139,710
Computer Science

As the number of jobs in which shared rather than individual work continues to grow, we are being forced to re-examine the way people work. This proposal suggests that in today's workplace, computer scientists must be adept at technical as well as communication skills. It also suggests that we, as educators, must be prepared to teach our students how to work in collaborative environments that improve programmer productivity. Towards this end, we plan to use an existing computer-supported cooperative problem solving environment to teach undergraduate computer science students to elicit software requirements. We believe that requirements elicitation and cooperative skills are highly interrelated and, as such, can be taught more effectively through the use of a computer-supported cooperative environment.

The underlying model of our computer-supported cooperative environment assumes that effective group communication is dependent on the use of effective communication competencies. In order to test this theory, we built a special interface that supports specific group competencies and at the same time facilitates the requirements elicitation task. The special interface is also equipped with tutoring and record keeping capabilities that allow us to track a group's progress and monitor their interactions. With the aid of this special interface, we now plan to develop a curriculum that is intended to teach undergraduate computer science students, specifically students enrolled in intermediate programming courses, how to elicit requirements for a software project and, at the same time, become more effective group problem solvers. Because the interface automatically stores and classifies the group's interactions, we will be able to evaluate the curriculum by determining a) the extent to which the groups demonstrate communication effectiveness, (2) the impact of our curriculum on group effectiveness, and (3) the extent to which the groups improve their requirements elicitation techniques while using our special interface versus those groups who use more conventional methods. Our findings and evaluations will be reported in journals and at professional conferences. Both the software and curriculum will be distributed to other interested institutions.

The long-term objective of this project is to expand the problem solving skills of our students and, thus, release into the computer science community more effective programmers. It is our hope that our computer-supported cooperative environment will encourage cooperative work and provide instructors with the ability to monitor individual as well as group performance. Through this system, students will be able to learn requirements elicitation techniques and, at the same time, gain valuable insight into how to work together on large team projects.

Undergraduate Parallel Computing Curriculum Development

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DUE-9156031
FY 1992 $ 87,443
FY 1993 $ 70,100
Computer Science

Our objective has been to develop materials for teaching parallel computing at the undergraduate level, particularly materials for teaching laboratories where students write, test, and time parallel programs.

We are developing a collection of modules for teaching parallel computing labs which can be used in different ways. They are appropriate for use as a series of laboratories for a course focusing on parallel computing. Many are appropriate for use in a unit on parallel computing in the context of other computer science course, covering subjects such as programming languages, operating systems, artificial intelligence, computer organization, or simulation.

This project began in 1991, supported by an initial NSF UCC grant. During that summer we held a workshop at Colgate University. After the workshop, participants revised draft modules which they had presented and the four senior investigators for the project edited a draft collection of 15 modules. This collection was distributed to over 60 individuals for review and trial use in early 1992.

In the summer of 1992 we held a second workshop at Colgate, supported by the current NSF UCC grant. At this workshop several new modules were presented and the draft collection was reviewed. We are now working on revisions to the modules and editing of a collection of modules focused on distributed memory, message-passing parallel computers. We are also negotiating arrangements for publication of the collection. We are making modules not included in the collection available to interested parties.

The modules which we are developing have been undergoing continual evaluation, first through the critiques conducted at the two workshops, second through the wide distribution of the draft collection for evaluation, and finally through the scrutiny of the senior investigators as editors and the review of potential publishers. We plan to have a collection of modules published in 1993. We will also have supplementary materials such as an instructor's mamlal and sample programs available electronically. An article including some mention of our work (based on a telephone interview) appeared in the September 1992 issue of *IEEE Spectrum*.

Our work will provide materials for teaching parallel computing laboratories at the undergraduate level. Such materials have heretofore been fragmentary at best.

This project has been built on the cooperation of a large group of people from institutions all over the United States and the world. The four senior investigators represent Colgate University, SUNY Oswego, Bucknell University, and Macalester College.

The Development of the "Closed Laboratory" Component in an Undergraduate Computer Science Curriculum

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DUE-9156112
FY1992 $ 204,514
FY1993 $ 200,334
FY1994 $ 200,152
Computer Science

As a discipline, Computer Science has seen many dramatic changes in its brief history. Through new textbooks and an evolving curriculum, the content of the undergraduate Computer Science education has, for the most part, kept pace with these changes. But the pedagogy has hardly changed. It emphasizes individual skill in writing, from scratch, small programs in a dead language. This emphasis is the antithesis of what is needed by a contemporary computing professional.

The objective of our project is to support the development and evaluation of a new undergraduate curriculum and supporting materials focused around the practice of computing, especially in the first two undergraduate years. We believe this pedagogical shift has, by far, the most leverage for improving undergraduate Computer Science education.

The focus of our new curriculum is a core sequence of closed laboratories. Lecture materials and content will be supportive of the laboratories rather than the other way around. While content can always be improved, we cannot expect to make quantum improvements. Laboratories, by contrast, have been largely neglected in this "laboratory science."

The Computer Science Department is developing a practice-centric undergraduate Computer Science curriculum; specifically, it is developing a collection of laboratory materials and exercises which will support this approach. Also central to this approach is an increased degree of rigor in all courses, coupled with the early introduction and subsequent use of modern software development methods and tools.

In our new computer laboratory, furnished with state-of-the-art hardware and software, students will work together through a series of exercises designed to encourage teamwork and brainstorming while reinforcing course content. These exercises are based on large hardware/software systems, incorporating actual industrial/corporate hardware and software products. The results of the students' work will be exhibited and critiqued by peers. The exercises will also employ the case-study model to facilitate understanding of an entire system with fun equipment such as sound generators, robot arms, etc., available for laboratory projects. The use of advanced CASE tools will also be part of laboratory exercises.

Each laboratory exercise as well as the overall curriculum will be evaluated using surveys, pretest/posttest, interviews, etc. Evaluations will be done on a continuous basis for each set of closed laboratory exercises. This will allow for modification of the material over several groups of students. Also, questionnaires for graduates and their employers will provide needed information about the long-term benefits of the revised undergraduate Computer Science curriculum. When the initial sequence of introductory courses has attained the stated objective, we plan to conduct "beta tests" of the materials at other schools.

We strongly believe this "closed laboratory" approach will provide the student with more real world experience while learning the basic tenets of computer science.

Multimedia Courseware on Computing and Human Values

Terrell W. Bynum	DUE-9224159
Southern Connecticut State	FY1993 $ 99,800
New Haven, CT 06515	Computer Science

This pilot project will develop and test one interactive multimedia courseware module on social, ethical, and professional issues that arise from computing technology, and develop detailed plans for two other modules. The first module will highlight the history of computer ethics, consider how the meaning of the term has changed over the last two decades and compare this field with other branches of applied ethics, explore important concepts such as privacy and responsibility and include scenarios that add interest and reality to the concepts. The two planned stacks will focus on issues of professional responsibility, and issues of access and equity for persons with disabilities. Multimedia "HyperCard stacks" combine video clips, sound bites, graphics and text. The first stack will be tested by classroom teachers and by students in interactive independent study. It will be disseminated at cost to the universities and scholars that request it. Also, demonstrations will be presented at national conferences and workshops. The stack will serve as a prototype for high quality, cost effective, state of the art curriculum materials on computing and human values.

A Multi-disciplinary Task Force to Develop a Framework for an Information Science and Engineering Discipline

Michael C. Mulder	DUE-9352944
University of Southwestern Louisiana	FY1993 $ 20,480
Lafayette, LA 70504	Computer Science

This multidisciplinary task force will develop a framework (i.e., definitions, contributing disciplines, design/implementation issues, major needs, major issues) for identifying the discipline of Information Science and Engineering (IS & E), that is consistent with the modern need for information. It is expected that an innovative, technical framework will be developed that integrates the following fields of study and practice: data base engineering, query languages, telecommunications, human/computer interfaces, organizational structure/operations, operations management, other elements of computer science, and computer engineering. Two recurring themes that will be embedded within this framework will be problem solving/design methods and applications and hands-on implementation skills.

ENGINEERING

The Freshman Engineering Experience

Larry J. Shuman, John F. Patzer	DUE-9254271
University of Pittsburgh	FY 1993 $ 199,999
Pittsburgh, PA 15260	Engineering

We are developing a comprehensive, integrated freshman educational experience which is suitable for both engineering and potential engineering students. This will provide students with a "hands-on" introduction to engineering methodologies and problem solving. The curricular material for this two-course sequence will enable students to integrate their current knowledge of mathematics, physics and chemistry into introductory engineering science, and thus prepare for follow-up courses in their engineering education. Carefully constructed open-ended problems will be used to motivate students to acquire the knowledge and skills needed for a world in which problems have no one right answer. Development of written and oral communication skills and teamwork in problem solving also will be emphasized.

The project involves faculty from the University of Pittsburgh School of Engineering as well as from Pitt's branch campuses at Bradford, Greensburg, Johnstown and Titusville, and from the Community College of Allegheny County (CCAC). These latter institutions, along with Pitt's Colleges of Arts and Sciences and General Studies, collectively account for over 75% of the 225 students who annually transfer into the School of Engineering. Thus a secondary objective is to better facilitate this transfer process.

An important part of this project is the evaluation of curricular effectiveness and the assessment of the impact of the new courses on both student attitudes toward engineering and student performance in course knowledge content compared to more traditional courses. The lag in introduction of the new course material at the branch campuses and CCAC provides an opportunity to evaluate the new curriculum materials against more traditional approaches. A second element of evaluation includes an in-depth analysis of the freshman engineers' approach to solving open-ended problems. This involves the elicitation and analysis of think-aloud protocols from a small sample of students.

New hands-on, project-oriented curricular material, complete with instructor's manuals, will be available for other colleges and universities to adopt for their courses without benefit of a more formal curriculum transfer. We will particularly target those institutions who have a "3/2" program with the School of Engineering as the logical next candidates for distribution.

A Non-traditional Classroom for Engineering Materials Instruction Integrated with Teacher Preparation Activities

John C. McClure, John B. Peper	DUE-9254360
University of Texas El Paso	FY1993 $ 99,572
El Paso, TX 79968	Engineering

In a cooperative effort between the College of Education and the College of Engineering, various techniques will be tested in the basic and required course, Materials Selection, (taught by one of the PI's) to involve students more intensely in the learning process. Among the techniques that will be used are: video tapes study with faculty and TAs as facilitators, student projects, and an interactive socratic-type classroom environment. Naturalistic evaluation techniques will be supervised by the College of Education. Students preparing to become teachers of science will also be involved in the project as participants and later assistants in the engineering course. They will also be affiliated with ongoing research projects in materials engineering and will participate in the research activities.

Video Resources for Instruction in Introductory Engineering Thermodynamics

Philip S. Schmidt, John R. Howell	DUE-9254005
University of Texas Austin	FY1993 $ 105,984
Austin, TX 78712	FY1994 $ 99,255
	Engineering

The proposed project will produce a series of eleven videotapes for use in undergraduate instruction in introductory engineering thermodynamics. The tapes will use a combination of live-action video to illustrate important applications of thermodynamics and computer-generated graphics to illustrate fundamental concepts. Historical background on important people and events in the development of thermodynamics will also be presented. Topics covered in the programs will include energy, heat and work concepts, thermodynamic properties and processes in gases, liquids and mixtures, energy transformations and First Law analysis of closed and open systems, reversibility and irreversibility, Second law analysis and entropy, isentropic processes and component efficiency, Carnot and thermodynamic cycle performance, and principles and applications of various power and refrigeration cycles. The tapes will be used in several core thermodynamics courses at the University of Texas at Austin with a total enrollment of 800 students annually. They will also be made available for use in a pilot evaluation at five other universities, and subsequently will be distributed nationally on a low cost basis. When used nationally, these materials could impact more than 25,000 engineering students per year in introductory thermodynamics courses.

A Creative Approach to Teaching Undergraduate Mechanics Emphasizing Development of Instructional Tools to Enhance Spatial Visualization and Inductive Learning

Charles M. Krousgrill, Anil K. Bajaj,	DUE-9254129
J. D. Jones	FY1993 $ 79,999
Purdue University	Engineering
West Lafayette, IN 47907	

The primary objective of this project is the development of a creative approach to the teaching of sophomore-level engineering mechanics courses which stimulate the students' thinking beyond a problem-solving level and helps students overcome fundamental deficiencies in their ability to conceptualize problems. The stimuli are to be supplied by adding a "hands-on" component to the teaching and learning experience, a component which is known to be critical in the retention of learned material. Specifically, this project will design and develop a mechanics toolbox consisting of basic building block components for individual experimentation by the students. The immediate impact of this learning tool will be that students will develop improved physical insight, engineering relevancy and spatial visualization of mechanics problems. The long range impact of the usage of the mechanics toolbox will be to help capture the interest of the students at an early stage of their education thereby fostering an increased interest and enthusiasm in engineering. In addition, the proposed work will allow for exploration of problems from a perspective which encourages inductive learning, a learning style which is more natural for the students than the traditional deductive style. Critical review and evaluation of the proposed work will be conducted through formative evaluations by participating students and faculty. Finally, products from this work will be in the form of a working mechanics toolbox set. These deliverables along with the pedagogical contributions of the research will be disseminated through technical publications.

Engineering Technology Instruction for the 21st Century: Mastery of Engineering Technology

Bernard E. Mohr, Bruce R. Naples,	DUE-9254187
Edward V. Chapel, Thomas J. Gerson	FY1993 $ 303,395
CUNY Queensborough Community College	Engineering
New York, NY 11364	

This project is aimed at strengthening and modernizing academic preparation in Electrical and Computer Engineering Technology. Employers have increased academic hiring requirements commensurate with revolutionary developments and growth of emerging computer-related technology. Minorities who are expected to account for a growing percentage of the work force are grossly underrepresented in technical occupations. This exemplar project employs a comprehensive strategy to improve student mastery of engineering technology, heighten student academic participation and achievement, emulate an industrial workplace environment, and enhance academic and employment opportunities. Activities in two fundamentals laboratories will be restructured to foster improvements in the mastery of laboratory skills. Project activities include the design and development of on-line instructional resources on the departments' local area network, computer-based data acquisition and analyses, and multimedia courseware for presentations and lectures. Also included in the activities is an extensive evaluation component and a national and regional program for dissemination of project methodologies and results.

Developing Spatial Visualization Skills in Freshman Engineers

Beverly J. Gimmestad, Sheryl S. Marlor	DUE-9254207
Michigan Technological University	FY1993 $ 80,000
Houghton, MI 49931	FY1994 $ 40,000
	Engineering

Spatial visualization is known to be a valuable and often essential skill for engineers in all of the disciplines. The purpose of this project is to design a three credit course in three-dimensional spatial visualization and to develop the necessary materials from which the course can be taught. These materials will include a written textbook and a laboratory manual. The laboratory exercises will involve sketching and computer graphics and will also utilize the visualization capabilities of IDEAS software.

Freshman engineering students with weak 3-D visualization skills are the target audience for this course. Women have been found to be approximately three times less likely than men to have well-developed spatial visualization skills. Thus, it is expected that the proposed course will increase the accessibility of engineering studies to women. The goal of this course is to provide the prerequisite spatial visualization skills needed by students to succeed in their subsequent engineering design graphics courses and in their later study and work.

Designing a Portable Technical Literacy Course for use in California

Katy Disney, Charlotte E. Behm	DUE-9254172
Mission College	FY1993 $ 34,884
Santa Clara, CA 95054	Engineering

This project is designed to increase the technical literacy and awareness of the general population of Mission College students through cooperation with regional colleges and universities as well as industry. The College plans to develop a course which is easily transportable throughout the State of California. A statewide network is currently in place through which the results can be quickly disseminated. Project activities include outreach to scientists and engineers in the community, collaboration with faculty in various disciplines, visiting counterpart schools, researching topics, experimentation, and the construction of simple prototypes.

Focus on Interactive Problem Solving in a First-Year Engineering Course

H. Scott Fogler	DUE-9254354
University of Michigan	FY1993 $ 93,503
Ann Arbor, MI 48109-1220	FY1994 $ 106,497
	Engineering

Typical engineering courses emphasize closed-ended examples and problems. While these problems aid in the development of convergent thinking skills, they usually do not provide practice for improving the divergent thinking patterns essential for the solution of industrial and research problems. This proposal presents a plan for enhancing the problem-solving and synthesis skills of first-year engineering students to develop a mind-set lasting throughout their college careers and professional lives. This enhancement will be achieved through an innovative, required first-year course.

In a first-year class of over 1,000 students, it is virtually impossible to achieve the ideal one-on-one interaction required to develop divergent thinking skills. In the proposed first-year course interactive computer modules and open-ended problems will be used in conjunction with lectures and exercises that present a robust problem solving heuristic. The computer modules will allow the students to make decisions in gray areas at branch points in decision trees, to troubleshoot, and to make decisions on what data they need to access from the computer. Our previous work on writing interactive modules has resulted in our developing strategies that individualize the instruction.

The students will then work in groups to apply these concepts to solve open-ended design problems, written at such a level that first-year students will be able to generate innovative solutions. These group interactions, requiring a written report, will provide a framework to enhance the students' interpersonal and communications skills.

The proposed project will initially have the potential to influence over 1,000 first-year engineering students. Further, the modules and material developed will then be distributed to other engineering colleges across the nation.

Curriculum Development - Manufacturing Systems

Frank A. Dolan, James G. Hudgings	DUE-9254293
New Jersey Institute of Technology	FY1993 $ 92,000
Newark, NJ 07102	Engineering

This is a joint project of the New Jersey Institute of Technology as lead institution for the North/Central New Jersey and Camden County College as lead institution for the Southern New Jersey CIM Consortia. The consortia operate fully articulated programs aimed at the AAS and BSET degrees in Manufacturing Engineering Technology. The consortia consist of 13 community colleges and NJIT in the North/Central; Camden County College, 5 other community colleges and NJIT in the Southern.

Articulated curricula of the two consortia include a two-course sequence in Manufacturing Systems. This sequence is critical to the success of the program. Significant deviations in course content and emphasis among the member colleges have been noted.

This project will solicit input from the manufacturing industry on required skills which should be attained through the first course of the two-course sequence. During a summer Curriculum Development Institute, selected faculty members will develop model curricula and training modules. The project will also identify possibilities for sharing of laboratory resources in support of the model.

Course Development: Introduction to Electrical and Computer Engineering

Mario J. Gonzalez, Michaek F. Becker,	DUE-9346398
Christine M. Maziar, Lawrence T. Pillage,	FY 1992 $ 128,059
Terry J. Wagner	FY 1993 $ 156,469
University of Texas - Austin	Engineering
Austin, TX 78712	

This project is designed to continue the development of an introductory course that provides contact between freshmen and the Department of Electrical and Computer Engineering and demonstrates the relationship between science and mathematics fundamentals and their application in a rigorous program of study. Our goal is to reduce attrition between 15 and 25 percent.

A significant amount of faculty time will be invested during the first year of this two-year project revising and refining the course content after our initial experience in spring l992. In addition, we will complete development of the first case study, develop two others, complete the textbook that will accompany the course, perform a comprehensive study of student retention and evaluate the resources necessary for a full-scale implementation.

We expect to demonstrate that early exposure to engineering fundamentals and the engineering design process will improve the retention of freshmen in ECE at The University of Texas - Austin. In addition, we anticipate that our work will lead to an improved curriculum in our department, produce a textbook that can be utilized in other ECE departments, and provide a model for a freshman ECE curriculum.

The Integration of Economic Principles with Design in the Engineering Science Component of the Undergraduate Curriculum

Gerald J. Thuesen, William G. Sullivan	DUE-9346867
Georgia Tech Research Corporation	FY 1992 $ 204,868
Atlanta, GA 30332	FY 1993 $ 168,373
	FY 1994 $ 171,948
	Engineering

The project is intended to demonstrate how the design activity, fully integrated with economic principles, can be effectively utilized to teach the engineering science component of the undergraduate curriculum. We propose to build on and extend the experimental core curriculum being developed at Texas A&M University (with NSF funding) such that design and economic principles will become infused into required engineering science courses in the curriculum at the Georgia Institute of Technology. Faculty from four engineering disciplines at Georgia Tech have agreed to develop and test our experimental courses over several years and to report their experiences with a design-focused teaching paradigm. Additionally, we propose to devise a new course dealing with the Economics of Engineering Design that bridges from the lower to the upper division in the undergraduate curriculum. Faculty from 5 different universities will assist in preparing educational materials for this new course and for the economics component of the modified engineering science core courses. To provide a second experimental test bed for this course Virginia Polytechnic Institute and State University and North Carolina A&T State University have agreed to teach it during the second and third years of our 4-year project. Evaluation procedures for modified engineering science core courses at Georgia Tech and for the economics of design course will be carefully developed and carried out over the duration of the research. Effective mechanisms (e.g., workshops) for transferring results of our research to other universities will also be developed. Finally, significant support exists for this multi-disciplinary effort as evidenced by the fact that one-third of the entire budget will be cost-shared by participating institutions.

Interactive Tutorial for Engineering Mathematics with Applications in Electrical and Computer Engineering

Sally L. Wood	DUE-9156103
Santa Clara University	FY 1992 $ 86,727
Santa Clara, CA 95053	FY 1993 $ 88,154
	Engineering

Many students of engineering and science have difficulty in upper division courses because their command of the mathematics they studied in the lower division is limited. Topics not used for several years can be forgotten, and the connection of the mathematical theory to engineering disciplines may be unclear. This leads to under performance by individual students and generally slower progress in courses where the basic mathematics must be reviewed.

The objective of this investigation is the design, development, and evaluation of a prototype workstation-based engineering mathematics tutorial. It will allow interactive demonstrations and review of basic concepts both abstractly and in the context of applications across engineering disciplines. This vertically-integrated tutorial would be used by professors and students in formal classroom settings and in informal groups. It will also provide an opportunity for individual exploration analogous to a reserve reading room. This project will be a new resource to make engineering education more efficient, more interesting, and more accessible. It is not intended to replace traditional lectures, hands-on laboratories, commercial computer-aided design tools, or student testing. The decreased cost of high-performance workstations and the wide availability of standard windowing systems for interactive application software development make interactive tutorials such as this possible in two respects. The software can be developed in a reasonable amount of time with primarily engineering application expertise, and most universities have a network of workstations available for student use. The tutorial software is being written in the C language using Motif so that it will be portable to almost any UNIX workstation. One of the modules of the tutorial is being developed and will be tested by undergraduate engineering students for relevant content and ease of use. Using feedback from this testing, that module will be improved and three to six additional modules will be developed in a consistent structure. Audio output and stored images of real applications will supplement the dynamic graphical presentations of the tutorial.

Evaluation will be done at several stages of development as well as when the project is complete. Engineering students will be asked to use the system as part of their introductory discipline-specific engineering courses. In electrical engineering this will be the first circuits and fields courses. Both the basic review demonstrations and the course specific applications will be used. Feedback from both the students and the faculty will be used to assess the contribution of the software. This will focus on improved understanding of the mathematics and the engineering application. The tutorial will also be used in some of the upper division classes which rely most heavily on engineering mathematics.

Dissemination of the software will be made possible by network access to any university with UNIX workstations. A document describing the use of the software will be published and two public presentations and demonstrations at engineering education meetings are planned. This software will also be made available to all of the active engineering education coalitions. The broad target audience expected to benefit from this tutorial software includes, but is not limited to, students who have some weakness in their mathematics background for any of a variety of reasons. Students may have attended a rural or urban high school which did not offer advanced mathematics courses so they have more new mathematical concepts to mentally integrate in a shorter time than the more prepared undergraduate students. Other students who only become interested in engineering as freshmen may not have elected to take advantage of the mathematics courses that were available before college.

This tutorial system will make an important contribution to improvement of the quality and accessibility of engineering education. It will help show the lower-division students the connections between the mathematics they are studying and the applications in engineering. It will also help students succeed in the upper-division courses. Since it can be used individually or in groups in a variety of interactive modes, it will match the needs of a large number of engineering students.

Longitudinal Effects of Innovative Teaching Methods in the Undergraduate Engineering Curriculum

Richard M. Felder, E. Jacquelin Dietz	DUE-9245308
Lynne Baker-Ward	FY 1991 $ 59,989
North Carolina State University	FY 1992 $ 59,973
Raleigh, NC 27695-8208	Engineering

A cohort of students is being instructed by the principal investigator in five chemical engineering courses taught in successive semesters, beginning with the introductory course in the first semester of the sophomore year. The instruction integrates a number of methods that have been shown by educational research to promote effective learning, including cooperative (team-based) learning, and frequent assignment of open-ended problems and problem creation exercises in class and homework. Two groups are being studied and compared--an experimental group consisting of students who experience the proposed approach for three or more semesters and a comparison group containing students who proceed through the curriculum as normally taught. The experiments have been designed and data analyses performed by an interdisciplinary team of investigators from the departments of Chemical Engineering, Psychology, Counselor Education, and Statistics.

The objective of the research is to demonstrate that systematic and repeated use of the specified instructional methods can have significant beneficial effects on academic performance, retention, problem solving ability and creativity, attitude toward chemical engineering as a curriculum and career choice, and self-concept. The effects are expected to be particularly pronounced for students considered to be academically at-risk. The study will generate an unprecedented body of data on over 300 entering engineering sophomores relating to their backgrounds, reasons for choosing engineering, academic strengths and weaknesses, levels of confidence and anxiety, academic performance, and retention and graduation in engineering. North Carolina State University has the tenth largest engineering school in the country, so that the test data should be generalizable to a broad cross section of beginning engineering students nationwide.

The results will be disseminated in journal articles, conference presentations, and effective teaching workshops directed by the principal investigator. Preliminary results were presented at the 1992 Annual Meeting of the ASEE and will appear in a forthcoming article in the *Journal of Engineering Education.*

Engineering and Modern Society - A Freshman Course

David P. Billington	DUE-9150575
Princeton University	FY 1993 $ 80,000
Princeton, NJ 08544	Engineering

The program is developing an introductory-level course in engineering aimed at freshman engineering students, but open to all students. The new course, made up of a series of integrated teaching units, is focusing on the total system within which modern engineering operates and on the centrality of innovation for engineering. The course also introduces students to techniques for more effective communication through written and visual means. In addition to the teaching units and the course itself, a network of teachers is being established to disseminate the new materials. These materials introduce students to the scientific basis for engineering, the social context within which modern engineering arises, and the intimate relationship between engineering and modern culture.

ANEX/RIED: Analysis, Experiment, and Reading and Interpretation of Engineering Drawings in a Portable Structural Model Laboratory

Richard A. Behr	DUE-9246846
University of Missouri - Rolla	FY 1991 $ 55,000
Rolla, MO 65401	FY 1992 $ 10,000
	Engineering

This project involves the development and implementation of a new teaching facility and teaching method called "ANEX"--an acronym for Analysis and Experiment. Students using ANEX are first taught how to use a commercial structural analysis computer program (M-STRUDL) that is used to predict the behavior of small-scale models that are set up for testing in the custom-built ANEX test bed. Immediately after performing the M-STRUDL analysis, students make electronic measurements on their models and they compare the M-STRUDL predictions with the experimental data that they have just gathered. The challenge then remains to explain parallels and divergence's between these analytical and experimental results. A prototype expert system is now being developed at UMR to assist students in this troubleshooting task.

In addition to ANEX, a software package called "RIED" (Reading and Interpretation of Engineering Drawings) is being developed at the University of New Hampshire (UNH). The purpose of RIED is to show complete engineering drawings and hypertext images of "real world" versions of the small-scale structural models that are commonly studied in the ANEX facility.

As a result of a previous NSF Instrumentation and Laboratory Improvement Grant (NSF Grant No. EID-9052026), four ANEX stations are now operational at UMR and one station is being fabricated at UNH. ANEX is being used extensively in a required, introductory structural analysis course at UMR for in-class demonstrations by instructors, for teaching the M-STRUDL software package, for student designed experiments, and for semester-long, design--build--test competitions. Student-designed experiments and design projects are performed in a group working environment with a heavy emphasis on oral presentations and written reports. Student feedback continues to shape and improve the use of ANEX in the undergraduate curriculum. Plans are also under way to increase the involvement of precollege students and lower-division undergraduates in ANEX-related project activities.

The ANEX/RIED development project has produced a Masters thesis, a published journal article (two more articles are currently under review), two specialty conference proceedings articles, and numerous seminars and demonstrations to professional engineers, freshman engineering students, precollege students, UMR alumni, and engineering faculty and students at other universities. The plan is to make ANEX software and hardware available for commercial distribution to academic institutions nationwide.

Plans are also under way to increase the involvement of precollege students and lower-division undergraduates in ANEX-related project activities.

GEOSCIENCE

Acquisition, Analysis and Visualization Approach to Introductory Geological Environmental Laboratory

Dennis S. Hodge, Michael F. Sheridan, Paul H. Reitan	DUE-9254211
SUNY at Buffalo	FY1993 $ 101.092
Buffalo, NY 14260	FY1994 $ 72,878
	Geoscience

The project is developing new laboratory exercises for non-science majors in introductory geology courses. Each exercise is divided into a 1) data acquisition 2) data analysis and 3) model visualization/testing phase. RISC-based graphics work stations, electronic measuring devices and field tests are being used to bring 3-D visualizations into the elementary course sequence. With the introduction of computer analysis of data and with computer modeling of geologic processes, non-science students are developing scientific methods and learning about critical environmental problems. Although these approaches are being developed for classes with large enrollments, the laboratory portion of the course involves 20-25 students in each section, requires individual participation and introduces the use of computer visualization models to evaluate each simple hypothesis.

Computer Based Media and Lab Exercises for a Lower Division Oceanography Course

W. A. Prothero	DUE-9254192
University of California Santa Barbara	FY1993 $ 105,641
Santa Barbara, CA 93106	Geoscience

Oceanography is taken by 25% - 40% of our first year class, and it may be the only science course many of these students experience. As a large class, it has high visibility on campus and presents a vital challenge in efforts to provide each student with a dynamic and exciting learning experience. This project is creating a set of interactive Macintosh computer based laboratory tutorial/simulations, a comprehensive help database, and an associated workbook. This material will be integrated with the existing graphics database and computer automated quiz serving and fading software, and it will be available on CD ROM and Internet to other colleges and universities teaching oceanography. Many of the ideas and approaches developed for this project also will be useful to others teaching large classes in other disciplines. The goal is to make this large class experience every bit as exciting and dynamic as that in smaller classes by creating material that will truly engage the students in the subject matter, supported by a class structure that encourages student responsibility and integrative thinking.

Interactive Earth Systems: A Curriculum and Course Development Project

Rama Murthy, Fred N. Finley,
E.C. Alexander Jr., Eville Gorham,
Lawrence Rudnick
University of Minnesota
Minneapolis, MN 55415

DUE-9345983
FY1993 $ 63,266
Geoscience

Six faculty members from several departments are developing a multidisciplinary two term course sequence titled "Interactive Earth Systems". The two courses at the introductory level are intended to help beginning college students understand that scientific knowledge is applicable to their lives and is important for contemporary human society. Students are introduced to an understanding of the evolving earth and its environments via four key concepts, each introduced by a specific case study: the nature of earth systems and interactions; cycles and flows in the earth systems; long time scale changes; and human interactions and catastrophic events. A special feature of the design is the use of individual modules of learning, each constructed on a specific topic. Each module consists of two one-hour lectures each week and two two hour sessions in which the students solve specific problems or answer specific questions in small cooperative groups of 3-4 students. Students taking these courses are gaining an understanding of the scientific laws governing changes in the natural world and the human implications of global changes.

INTERDISCIPLINARY

Science in the Liberal Arts Curriculum

William G. Becker, Michael J. Flower	DUE-9253973
Portland State University	FY1993 $ 181,749
Portland, OR 97207	Inter/Multidisciplinary

This two-year collaborative curriculum development project will develop and implement an innovative interdisciplinary Science in the Liberal Arts Curriculum at Portland State University and at Clackamas, Mt. Hood, and Portland Community Colleges. Faculty from the four institutions will cooperate in formulating a curriculum that provides liberal arts students with three types of interdisciplinary science courses that will meet the University's general education science requirement. Natural Science Inquiry courses will focus on open-ended laboratory and field studies in the manner recommended by Project Kaleidoscope.

The Science in the Liberal Arts Curriculum is designed to provide students an alternative way to meet the General Education science requirement. It will provide not only a necessary foundation of scientific facts and concepts but also a more varied and creative experience of the ways science is done, and a sense of the broader context within which facts have significance and science has consequence. In short, students should develop an appreciation for the value of science literacy as a part of active citizenship, understanding science's goals, methods, and overarching concepts, as well as science's function as a complex enterprise that takes place in specific social contexts shaped by, and in turn shaping, cultural, moral political, and economic values.

Key features include: doing science as science is done; working in collaborative research teams, using writing to learn, allowing inquiry to set course direction, ensuring that inquiry is open-ended and using computers. Central to this curriculum are "natural science communities of inquiry." Courses will be characterized by investigative laboratories, field studies and research projects, focusing on scientific processes of problem-posing, problem-solving, and persuasion. In general, the ability to work with facts, rather than the facts themselves, is to be emphasized. Courses will stress small group learning techniques and collective problem-solving of the sort done in science. Students will be encouraged to debate interpretations of data-as well as their positions on pressing scientific/political/social issues.

The Quantitative and Experimental Study of Human Nature

Eugene Galanter	DUE-9253980
Columbia University	FY1993 $ 100,573
New York, NY 10027	Inter/Multidisciplinary

Undergraduate scientific education may fail the novice in several ways. One may regard all introductory students as recruits to be readied for the more advanced work of a major; others view the education of the non-major as an obligation and offer material that does not attend to the needs of advanced instruction. We propose ultimately to develop an alternative--a two-year introductory program in the analysis of human nature from the biological to the social. This curriculum would parallel Columbia University's renowned program in Humanities that has been emulated by many colleges and universities. The course work in this new program would consist of transportable but interdependent modules that require careful reading and analysis of primary research papers. The readings would open opportunities for a variety of complementary projects. The current request is to fund a pilot program to develop and test a module in psychophysics and expand the quantitative adjuncts of a second module, molecular biology. The modules integrate lectures, peer discussion, demonstrations, field work, and experimentation to forge a real grasp of the methods and results of science. Students who complete the entire range of modules will be able to continue as science majors in biology, psychology or the social sciences. The portability of the modules will permit their use, individually or collectively, by other institutions, and we will plan such export to other colleges and universities.

Integrated Mathematics/Science Courses: An Inquiry-Discovery Model

Jack D. Ullman	DUE-9254178
CUNY Lehman College	FY1993 $ 172,858
Bronx, NY 10458	Inter/Multidisciplinary

Lehman College plans to address the problem of poor student preparation and the alienation of incoming students from mathematics and science by converting, as a model, one section of 45 to 50 students in the present core sequence required of incoming students (quantitative reasoning and natural sciences) to a two-semester combined mathematics-science course based on the inquiry-discovery method. A series of laboratory experiences will be developed in which the students are given tasks requiring higher-level thinking, but are not given explicit directions as to how to do them. The method requires the students to work in small groups with a tutor. The tutors will be science education students taking a specially-designed advanced education course in which they will learn the scientific concepts and develop experience with the inquiry/discovery method of learning.

Integrated-Science General Education Using a Hybrid Interdisciplinary Teaching Methodology

Lenard R.Troncale, Judith E. Jacobs
California State Polytechnic University Pomona
Pomona, CA 91768

DUE-9254119
FY1993 $ 99,999
Inter/Multidisciplinary

This project will in develop a three-course series earning 20 units of science general education for from 150 to 750 students from 30 majors in 4 non-science colleges across campus. Its major objective is for non-science students to achieve a deep understanding of the scientific method and the most important theories and mechanisms of seven sciences (Astronomy, Physics, Geology, Chemistry, Biology, Computer Science and Mathematics) integrated and presented, not by discipline, but rather by common features across the discipline as advocated by a recent AS report. An innovative hybrid method using computer based multimedia modules that instruct students in a dozen system processes as unifying themes, 36 in-depth case studies from each individual discipline, weekly discussion groups, skill training sessions, general assembly debates, a fully interdisciplinary lab and team teaching in all of the courses, will be used to further synthesize the best advantages of each training method, while overcoming its shortfalls. The project will result in five major products that are easily replicated such as an electronic library of multimedia modules, a library of published case-study pamphlets, a text on "Integrated Science," a cross-disciplinary lab manual, and a network of cooperating institutions. Dissemination across the Calif. State Univ. system is another major goal because with its 326,000 students on 20 campuses and central administration our cross-campus implementation of this unique Integrated Science GE program would reach a significant audience. The CSU produces 80% of the state's precollege teachers (14% of the nation's) which would spread the innovation of integrated science approaches, which are called for by several national studies, to an even larger audience resulting in more improvements in regional science literacy.

Connecting Science and Mathematics: An Integrated Program for Undergraduates

Carolyn C. Narasimhan
DePaul University
Chicago, IL 60604

DUE-9254323
FY1993 $ 124,545
Inter/Multidisciplinary

The focus is science and mathematics education for non-science majors. A team of ten faculty members from the science and mathematics departments at DePaul University will develop a three quarter, interdisciplinary science sequence, with mathematics integrated throughout. In the sequence, students will explore the basic principles underlying modern science and the growing degree to which multidisciplinary approaches are needed to attack problems in health, ecology, and the environment. The sequence will emphasize the scientific process, as well as major themes in physics, chemistry, and biology. Although the sequence will be developed for all non-science majors, the project will give special attention to those preparing to be teachers. In collaboration with DePaul's Center for Urban Education, the project will establish structured clinical experiences for education majors in public elementary and middle schools in Chicago. Acting as Scientists in Residence in these schools, students will adapt hands-on activities from the course for the children and teachers.

Improving Science and Mathematics Education through Integrated Content Interactive Discovery Learning

Clare C. Bailey, Aubra J. Riddle	DUE-9253963
Chew Lean Lee, Jane D. Gant	FY1993 $ 78,000
John Q. Mullins	Inter/Multidisciplinary
Florida Community College Jacksonville	
Jacksonville, FL 32202	

This is a project to develop an integrated introductory course in undergraduate science and mathematics by a team of faculty and professional staff in science, mathematics and psychology representing three of our four major campuses of Florida Community College at Jacksonville. The work is integral to the College's long range plan to revitalize the curriculum and make learning an exciting and rewarding process. The goals are to increase understanding and retention of complex subject matter, while at the same time make these enjoyable experiences, leading to the adoption of life-long learning habits by students.

Teaching faculty have teamed with psychologists versed in applications of learning and motivation theory to the classroom as well as in the application of technology to the learning process. The faculty team will develop an introductory level undergraduate course combining the central themes of cycles, information, and change common across scientific disciplines including botany, microbiology, chemistry, physics, and mathematics. The developers will team teach the course using strategies that integrate science and mathematics and focus on the interrelationships among the sciences and mathematics.

The course will be delivered in electronic classrooms that allow team teaching via telecommunications systems providing graphic, audio and visual interaction between faculty and students located on both the North and Downtown Campuses. The course will engage students in learning by discovery exploration and collaborative partnerships between students and faculty and administrators acting as mentors to student teams.

Cosmos and Evolution: An Exploration of Nature

Bruce MacLaren	DUE-9254153
Eastern Kentucky University	FY1993 $ 120,000
Richmond, KY 40475	Inter/Multidisciplinary

The project will design an interdisciplinary laboratory science course for non-science majors that explores the earth's past and its place in the universe. The course will be based on concepts common to all of science. It will include elements of and be taught by faculty from cosmology, physics, chemistry, geology and the life sciences. The centrally significant ideas of these disciplines will provide the focus for presentations and laboratory experiences. Faculty members who will teach in this course will themselves become "master learners", attending classes in other disciplines. There will be a four week workshop to design the course in 1993, a two week workshop to review, evaluate and revise it in 1994, and a two-day evaluation session in May, 1994. Upon completion of the grant, there will be six to eight faculty prepared to teach this innovative interdisciplinary class.

Science is a Liberal Art

Karen E. Johnson, Allen C. Rogerson	DUE-9254056
Catherine H. Shrady, John T. Bursnall	FY1993 $ 8,974
Saint Lawrence University	Inter/Multidisciplinary
Canton, NY 13617	

St. Lawrence University has recently begun a major initiative to improve its introductory science courses and enhance science education for non-science majors. This will be accomplished by first introducing more science into the interdisciplinary required freshman course (The First Year Program), and then offering more appropriate science distribution courses. Science modules will be developed for the First Year Program that will increase scientific awareness as well as literacy, will emphasize scientific reasoning, and will demonstrate the relationship between the natural sciences and other realms of human thought.

Basics for Technicians: An Integrated Course of Study Encompassing Introductory Mathematics, Chemistry and Physics

Judith Tavel	DUE-9254184
SUNY Dutchess Community College	FY1993 $ 115,000
Poughkeepsie, NY 12601	Inter/Multidisciplinary

Building on experience in programs to upgrade the educational background of personnel working in industry, Dutchess Community College will develop an integrated curriculum which could become a certificate program in basics for industrial technicians. A faculty team will develop a single, unified course integrating elements from what are currently separate courses in introductory mathematics, chemistry, physics, English and reading. Modern manufacturing will be used as the integrating theme. The project will significantly change the undergraduate learning experience through the employment of new curricula, innovative laboratories, new delivery systems, and fresh instructional materials. It is hoped that the project will be a blueprint for the development of an industrial technology certificate granting program which could be replicated by other institutions of higher education, particularly technical colleges.

Large-Scale Science Core Program for Non-Science Students

Frederick P. Greenleaf, Daniel Zwanziger,	DUE-9254301
Michael R. Rampino, Neville R. Kallenbach, Phillip Furmanski	FY1993 $ 357,190
New York University	Inter/Multidisciplinary
New York, NY 10012	

This proposal is offered by New York University's College of Arts and Science. A new, integrated series of introductory level science and mathematics courses will be developed for 1,600 non-science majors annually. The new curriculum takes into account the level of preparation and the extent of alienation of students from science and mathematics. The proposed curriculum aims to teach quantitative reasoning and emphasizes the open-ended questioning aspect of scientific thinking by means of lectures, inquiry-based laboratory experiences and recitations, and cooperative study teams. The intention is to develop, pilot, and refine an experimental version of such a multicourse curriculum in 1993-95, and in 1995 to replace the existing elective science and mathematics requirements at NYU with this program. All non-science majors will eventually have equal exposure to a corpus of interesting material in a Science Core Program. Design features will permit a certain measure of individualization in learning, as well as encourage the development of small, cooperative problem-solving study groups, breaking students out of isolation and replicating the research model of scientific inquiry. Instructional materials including texts, workbooks, teachers' manuals for faculty and teaching assistants will be developed.

Integrated Science for Elementary School Teachers: Restructuring Undergraduate Science Preparation for Teachers

Thomas E. Bitterwolf, David J. Oliver	DUE-9254158
Mickey E. Gunter, Robert J. Kearney	FY1993 $ 207,597
Steven D. Gammon	FY1994 $ 179,427
University of Idaho	FY1995 $ 124,797
Moscow, ID 83843	Inter/Multidisciplinary

This proposal seeks support to develop and implement a two-semester course of instruction designed to provide an integrated introduction to science for pre-service elementary education (first through eighth grade) majors. Concurrent with an inquiry-centered laboratory-based content course is the development of a practicum in which the pre-service students will work with master teacher/mentors teachers to translate science content into actual learning situations with children. This practicum will involve teachers and students from the Moscow, Idaho Public Schools and the Coeur d'Alene Reservation Schools. Additional school districts will be brought into participation as the project matures. At the end of three years, all elementary education majors will participate in this program. The curriculum will be developed by six research faculty from the departments of chemistry, biology, physics, geology, and biochemistry, in collaboration with science education specialists as well as teachers and administrators from regional schools. The courses will present science as a seamless whole through a blending of discovery-based activities and cooperative learning in a technology-rich environment. While this is a content curriculum, it will present science in ways that model the best teaching practices.

Critical Issues in Science, Technology, and Society: An Integrated Course Sequence

Leonard J. Waks, Ke Chung Kim	DUE-9254108
Robert G. Crane, Semih Eser	FY1993 $ 125,533
William F. Williams	Inter/Multidisciplinary
Pennsylvania State University Park	
University Park, PA 16801	

This project will develop an interdisciplinary course sequence aiming to satisfy natural and social science general education requirements. Three critical issue science modules and laboratories to be developed are: Global Climate Change, Energy Options for the Future, and Biodiversity Conservation. In addition to a thorough treatment of the science and engineering content of these issues, the course will innovate in content presentation in three explicit ways: (1) Theoretical knowledge will be integrated with labs and simulations for direct issue-investigation by the students. (2) All learning will converge on decision-making activities, including critical evaluations of contemporary news reports. (3) Decisions will be carried forward through exploration of problem solving action opportunities in the campus community, permitting students to use, immediately and in practical ways, what they learn in the course. As a result scientific knowledge will be communicated in a framework that will more effectively motivate especially non-science students and enhance creativity and critical thinking in science and technology. Research will be conducted to determine the effectiveness of these modules and innovative teaching strategies.

Fostering Problem-Solving Skills in Introductory Sciences: An Interactive Multimedia Curriculum

Daniel Friedman, Russell A. Poch	DUE-9346871
Howard Community College	FY 1992 $ 199,888
Columbia, MD 21044	FY 1993 $ 149,976
	Interdisciplinary

Problem: There is a great need to enhance the problem-solving skills of introductory science students, particularly those attending community colleges. While assessment data reveals this deficiency among many students, it is an area for which few programs or instructional materials currently exist.

Project Objective: Howard Community College proposes to produce one interactive multimedia program on problem-solving skills, drawing on typical problems found in introductory college-level biology, chemistry, and physics classes. The program will integrate audio, visual, textual, and graphics material in a highly interactive format that will present both generic problem-solving skills and discipline specific examples.

Project Plans: HCC expects to produce several concrete items from this project, including: (I) a diagnostic test to assess students' incoming and exiting competencies in problem-solving; (2) an interactive multimedia curriculum to teach students science-related problem-solving skills, including examples from the areas of biology, chemistry, and the physical sciences; (3) written workbook and manual to assist students and instructors in working with the interactive multimedia curriculum; and (4) revised classroom based curriculum to integrate the multimedia instructional program with the rest of the courses in introductory biology, chemistry, and physics.

Evaluation: HCC posits that there will still be a significant difference between the students who participate in the innovative curriculum compared to those taught in the traditional method, demonstrated by a positive outcome among students in the experimental group through such measures as: (I) improved pretest/posttest scores on the diagnostic test; (2) improved performance in final grades; (3) improved attitudes of students toward science and science classes; and (4) qualitative differences in the types of questions and problem-solving methodologies pursued by students.

Dissemination: Project curricular materials will be distributed by SETS (see below).

Collaborations: HCC will have a principal partner in developing this program: Cumberland County College (CCC) in New Jersey. The CCC faculty will review materials developed by HCC for the multimedia program, and their institutional researcher will assist in the development of a diagnostic test and the effectiveness evaluation plans and instruments.

Impact: The project should significantly improve the success rate of students in introductory biology, chemistry, and physics, particularly at community colleges.

Improving Scientific Literacy of Undergraduate Students Through "Hands-on" Multidisciplinary Science Courses

Rhoda K. Berenson, Shirley Aronson-Unger	DUE-9346877
Kimberley T. Pearlstein, Thomas G. O'Brien	FY 1992 $ 44,077
SUNY - Nassau Community College	FY 1993 $ 55,192
Garden City, NY 11530	FY 1994 $ 59,056
	Interdisciplinary

Studies indicate that most college graduates are scientifically illiterate. They take only one or two semesters of science, often repeating the same course subject they already studied in high school. However, understanding science-related public issues and newspaper articles that discuss these issues clearly requires a vocabulary and a comprehension that overlaps several scientific disciplines.

The overall objective of this project is to produce citizens who are capable of reading about and understanding contemporary scientific issues. To achieve this, we are:

(1) developing two-semester-long multidisciplinary laboratory science courses for non-science students which cohesively integrate the study of the physical and life sciences and emphasize scientific inquiry--observing, questioning, and making connections and inferences. One course examines the evolution of life in the context of the evolution of the earth and the evolution of the universe. The other explores the threshold between the animate and inanimate by examining the physics, chemistry and biology of a living cell and its interaction with its environment.

(2) preparing materials so that these will be student-centered "active learning" courses focusing on observation and experiment and relying heavily on collaborative student activities and non-textbook sources. We want students to feel capable of learning about science on their own, without professorial lectures.

(3) preparing faculty to teach these courses by first having them team-teach with more experienced faculty from different science disciplines.

In addition to the normal assessment of new courses conducted by the Nassau Community College Curriculum Committee, we are evaluating this project by (1) keeping extensive journals; (2) designing questionnaires for both students and faculty in the pilot offerings of the courses; (3) comparing student attendance records and withdrawal rates with those of students who take more traditional science courses; (4) preparing follow-up (one and two years after course completion) questionnaires to determine continued student interest in science; (5) preparing questionnaires assessing the effect of the project on participating faculty; and (6) consulting with an outside evaluator.

The results of the project will be disseminated by presentations at local and national meetings of the many scientific and educational organizations to which the principal investigators and other participating faculty belong.

We hope that after three years the courses will be mainstreamed into the Nassau Community College curriculum, 12 faculty members will be prepared to teach each course, and the courses and the materials prepared for them will serve as models and resources for other institutions.

Computing Across the Basic Sciences

Harry W. McLaughlin, Jack M. Wilson	DUE-9346879
Rensselaer Polytechnic Institute	FY1993 $ 160,100
Troy, NY 12180-3590	Inter/Multidisciplinary

Rensselaer is developing a series of cross-disciplinary activities at the science/computer interface for use in the basic science courses at Rensselaer and other universities. The structures of existing courses are being modified in order to allow students to confront developing interface technologies. These include nonlinear modeling, scientific computation, statistics, geometric modeling, and algorithm issues, each from a multidisciplinary vantage point. Materials for topics relating to nonlinear phenomena are being developed as a first step toward full implementation and as a demonstration of the feasibility of this approach. The project centers on use of these workstations in university level freshman and sophomore courses. It rests on a major university initiative: the 4500 undergraduates have unlimited access to 500 state-of-the-art scientific workstations. Of these, over 320 are earmarked for the exclusive use in freshman and sophomore courses. These new course materials will allow the introductory courses in mathematics, physics, chemistry, computer science, engineering, and earth/environmental science to reinforce one another through shared topics and activities. The materials will also have the effect of encouraging the instructors of the introductory courses to work more closely together than has, in the past, been traditional at most universities. The materials to be developed will include text materials, computer based problem-solving materials, simulations, microcomputer based laboratory activities, and video materials.

Darwin and Darwinism: Scientific Theory and Social Construction, the Undergraduate

Norman Fainstein	EW-20113
CUNY Baruch College	FY1993 $ 235,000
New York, NY 10010	Science and Humanties

Education is improved by showing the connections that help students to interrelate knowledge in various fields rather than to store it in separate mental compartments. The subject--Darwin and Darwinism--has broad and deep effects in the several disciplines of the arts and humanities and in contemporary culture. It presents an opportunity to improve the science literacy of future business people, educators, and citizens.

The four objectives of this project are: (1) to remold topics throughout the undergraduate curriculum so as to foster a strong thematic connection between disciplines in the natural sciences, the social sciences and the humanities, by engaging faculty in collaborative teaching and students in the study of a major scientific paradigm that reaches beyond the bounds of any single course; (2) to develop a new course on the theme; (3) to create a model for similar faculty collaborations that integrates the core courses of an undergraduate curriculum; and (4) to disseminate this model as a book of narratives, suggested readings, and suggestions for curriculum integration.

In the first year, fourteen faculty members are participating in a seminar to study Darwin's On the Origin of Species by Means of Natural Selection (1859), the context in which it was created and how it became the larger paradigm of "Darwinism." All participants develop curricular modules consisting of a narrative, based on the seminar presentations, reading lists, and suggestions for integration into specific undergraduate courses.

In the second year, participating faculty members collaborate to teach the new modules in base curriculum and elective courses. These faculty members will be available for consultation with students about new interdisciplinary assignments. The new program affects about 3000 students per year. They also team-teach an elective, interdisciplinary undergraduate course, "Darwin and Darwinism: Scientific Theory and Social Construction," to approximately fifty students. This course, when offered again, will include student recitation leaders.

Two internationally recognized authorities give public lectures to the college community and meet with faculty seminar participants in a workshop. Additional activities include a hands-on laboratory on modern methods of phylogenetic systematics and a behind-the-scenes visit to a major natural history museum.

The curricular modules and seminar content are reviewed by the faculty participants; faculty and students evaluate the effectiveness of the new modules using an instrument designed by the College. An outside evaluator, with expertise in curriculum innovation, conducts an ongoing and final evaluation of the project.

Participants share the modules with colleagues in their departments and, during the second year, in a special workshop with other colleagues across The City University of New York. Revised curricular modules are collected as a book for dissemination.

We expect these activities to enhance curricula, promote an interdisciplinary focus in several disciplines of the base curriculum, to foster a high degree of intellectual interaction among faculty members from several fields. In so doing Baruch College can attain a key, long standing objective--creating within our institution a sense of intellectual community that transcends the narrow and limiting disciplinary boundaries.

Society, Ethics, and Technology: An Interdisciplinary, Core, General Education Course

Morton Winston	EW-20180
Trenton State College	FY1993 $ 55,382
Trenton, NJ 08650-4700	Science and Humanities

As part of a new general education curriculum, Trenton State College is inaugurating a three course sequence of core, general education courses whose overall theme is "Understanding Humanity." Together the three core courses aim to provide all TSC students with a comprehensive, yet integrated framework for understanding human beings as creators of language, symbols, and art, as participants in social and cultural change, and as agents who transform their environments through the application of knowledge and tools.

The third course in the sequence, Society, Ethics, and Technology, provides the critical bridge between the humanistic and scientific/technological aspects of the core by providing a framework for understanding how human societies transform themselves through scientific discovery and technological innovation. Science and technology enlarge society's options. However, technological innovation also often carries with it unexpected social and environmental consequences, consequences which often create ethical questions concerning the responsible use of the powers we acquire through scientific and technological advance.

Selected ethical, social, and environmental issues associated with science and technology are explored through lectures, readings collected into a course reader specially designed for this course, and by means of seminar sections in which small groups of students work closely with members of the college's faculty. A two-week workshop for faculty members, drawn from diverse disciplines, will acquire the competence to teach seminar sections of this course.

The course is the product of several years of sustained effort among a diverse group of faculty; it is taught in a creative, and student-centered way; and it is being carefully and thoroughly evaluated as implementation proceeds. The results of this project are being disseminated by means of a book and conference presentations. The course may serve as a model for other institutions that wish to develop similar courses which promote a better understanding of the interdependence among science, technology, society, and ethics.

Conceiving the Commons: An Interdisciplinary Approach to Environmental Literacy

Gregg Mitman	EW-20153
University of Oklahoma	FY1993 $ 157,000
Norman, OK 73019	Science and Humanities

Whether encountered at the local, regional, or global level, environmental problems are complex and multifaceted. Commonly, however, they are approached from within single disciplinary perspectives, an approach that ignores many of their dimensions. The purpose of this project is to produce a synthetic approach to environmental questions. It provides students with a course of study that trains them to appreciate and meld perspectives on the environment, from the sciences and the humanities. Students develop skills in specific fields related to conservation and environmental biology while remaining firmly grounded in an interdisciplinary outlook. The goal of the project is to foster "environmental literacy": the ability to obtain and analyze information about environmental problems and to synthesize and evaluate proposed solutions.

The project, over a period of three years, generates a related set of core courses, which could serve as an area of concentration in conservation and environmental biology for students majoring in Botany, Philosophy, Political Science, or Zoology, or as a minor for students whose major is within other departments in the College of Arts and Sciences. The first year of the project is dedicated to planning and piloting an introductory team-taught course designed to acquaint students with interdisciplinary perspectives on environmental issues. In a faculty development seminar, instructors meet weekly with other interested faculty and visiting scholars to review relevant readings and to learn to integrate approaches from other disciplines. The introductory course, taught in the semester following the faculty development seminar, focuses on four case studies, which incorporate increasing levels of complexity in the learning process. As the semester unfolds, with each new case study, students are given more responsibility to learn on their own and to develop mastery of skills necessary for the synthesis of different perspectives.

Evaluation of the introductory course takes place in the second year of the project and the course is then "handed off" to a new team of instructors. Interested faculty are trained at a week-long summer workshop. In addition, project members develop and implement new courses in History of Science (on the history of ecology and environmentalism) and Philosophy (on environmental ethics) and revise existing courses in Botany (on plant ecology and environmental quality) and Political Science (on environmental policy).

The third year of the project focuses on the development and implementation of a senior capstone experience. In the capstone course, students synthesize the methodological approaches and underlying concepts and principles learned in the core program's single-disciplinary courses by designing an interdisciplinary solution to a practical environmental problem affecting their community. Because students in the capstone course have worked through the whole core program, the course provides an opportunity to evaluate the entire interdisciplinary concentration on its success at creating an interdisciplinary perspective on environmental issues and environmental literacy.

Dissemination takes place through published articles in such journals as The American Biology Teacher, and Conservation Biology, and through talks presented at national meetings of the respective professional disciplines involved and to regional and national meetings of education organizations such as Conservation Education Literacy Leadership. Unlike other interdisciplinary conservation biology programs, a substantial proportion of faculty involved in this program are from the humanities and a concerted effort has been made to establish a model for collaborative intellectual labor within the faculty development seminar and within the classroom.

New Perspectives: Humanities And Sciences

Richard Cobb-Stevens	EW-20105
Boston College University	FY1993 $ 90,000
Chestnut Hill, MA 02167	Science and Humanities

This project provides for the planning and implementation of four new core courses designed to integrate themes from the humanities and the sciences. Our goal is to overcome the fragmentation created by the typical core curriculum composed of a set of totally unrelated courses in the sciences and humanities. We hope thereby to encourage some students to pursue majors in mathematics and the sciences who might otherwise have been prevented from developing their talents in these fields, and to communicate to all of our students a sense of the continuity between humanistic and scientific modes of inquiry and of the complementarity of their insights.

The four courses are entitled: 1) New Scientific Visions, 2) Science and Literature, 3) Great Ideas in Mathematics, 4) Science and Religion: a New Paradigm. Each of these courses takes an historical approach to the interplay between scientific discoveries and cultural transformations. Each course has a common syllabus consisting almost exclusively of primary sources, i.e., significant mathematical, scientific, literary, and philosophic texts. Sixteen professors from nine different disciplines are participating for two consecutive summers in intensive month-long workshops devoted to the discussion of these texts and of appropriate teaching strategies for their presentation to students.

On the premise that intelligent discourse about science presupposes some mastery of the language and methods employed by scientists and mathematicians, each course gives concrete and detailed attention to mathematical demonstrations and to "hands-on" experimental observations and testing of hypotheses. On the premise that scientific inquiry is always situated in an historical context and is often guided by practical as well as theoretical interests, each course also calls attention in each historical period to criticisms of the scientific enterprise and to discussions of the social consequences of science policy.

Once the courses have been fully developed and have survived a trial period of two years, it will be possible to recruit more faculty and even to train senior teaching fellows as instructors. We have found that teaching fellows who have served a two-year apprenticeship in an earlier "Great Books" program were able to teach sections on their own quite competently. During the first year of actual instruction there will be on-going evaluations by students and faculty in order to enable "in-flight" corrections. After the second year of actual instruction, we shall attempt to determine whether or not the pilot versions of the proposed courses give promise of serving as models for new ventures of a similar type. At the end of the proposed two-year funding period, we will submit progress reports to the editors of Change and The Chronicle of Higher Education.

The Adirondacks: A General Education Coordinated Studies Program in Environmental Studies

J.T. Omohundro	EW-20174
SUNY Potsdam	FY1993 $ 109,565
Potsdam, NY 13676	Science and Humanities

Potsdam College is addressing a disciplinary specialization and fragmentation, a lack of attention to environmental issues in our General Education program, and a lack of thematic coherence and interdisciplinary competencies in General Education. In this project we are developing a pilot course of study which coheres thematically and integrates the humanities, sciences, and social sciences. To accomplish our objectives we are developing a one-semester 'modified' coordinated studies pilot for fifty first-year students following the theme of environmental studies, with the local Adirondacks as a primary case study. Students are engaged full time in the program while the six faculty participate between halftime and quarter time. Faculty from five disciplines art history and studio, geology, chemistry, literature and writing, and sociology share common weekly themes such as energy, ecosystems, balance and equilibrium in ecological systems, development, imagination, and structure. We investigate the mutual influence among science society and arts in thinking about nature. More than half of the weekly class hours are led by two or more faculty in teams. Instruction features active learning through labs and studios, field trips, collaborative learning in the classroom, group projects and the use of computer networks for communication and research. External and internal evaluators will assist the team. The evaluation utilizes paired experimental and control (non-pilot) first-year students, pre- and post-tested in several ways. We are evaluating coherency of student learning through portfolio evaluation, student presentations in public for, and with a variety of academic and student development inventories and attitudinal surveys. We will also analyze major selection, retention, and grades.

To disseminate our results, instructors will report on the pilot at professional meetings like the Association for General and Liberal Studies, the Environmental Sociology Committee, and The Association for Study of Literature and Environment. As we developed the pilot, we included other faculty in our workshops. As we teach the pilot, we operate a "faculty visitor program" bringing in colleagues from Potsdam College and neighboring schools to observe, discuss our methods in workshops, and contribute as guest teachers. We also plan to report in various journals.

We intend the pilot to be significant by demonstrating the value of a new model of learning communities which operates within the strict resource limitations of a public four year college. The pilot should better connect students to faculty, to the local region, to each other and the institution. Students are taking charge of their own education and forging links between their courses. Finally, we intend to inspire regularly offered successors not only on environmental themes but also other integrations of arts, sciences, and social sciences, using the modified coordinated studies structure and the new teaching methods.

The Study of Mind Program: An Interdisciplinary Major

E.S. Reed	EW-20126
Franklin and Marshall College	FY1993 $ 62,837
Lancaster, PA 17604	Science and Humanities

The Study of Mind Program offers a model undergraduate curriculum designed to integrate humanistic and scientific study. In order to reconcile the demands of both scientific and humanistic education, the curriculum is problem-, not discipline-centered. The curriculum is designed on a core-plus-track model: All students start with a core set of courses which introduce them to the various issues and methods involved in studying the human mind. After completing this core, each student chooses to work in one of three more specialized "tracks." In these tracks, students focus on more narrowly defined problems related to the study of mind, requiring them to develop mastery in at least one methodology from a scientific field and one from a field in the humanities. The core and each of the tracks approximate the workload of an academic minor. In order to facilitate the development of a truly integrated curriculum, our program emphasizes faculty development through a variety of seminars, workshops, and lectures. Our goal is to encourage faculty to participate in the program as a learning experience for themselves as well as for their students. Our activities include a significant amount of self-evaluation which we hope to use in order to modify and improve the operation of our program. We will be inviting a series of distinguished scholars in the relevant disciplines to visit our campus and help us to evaluate our program. The Study of Mind activities concludes with a two week "Institute" style workshop in which both local and visiting faculty will summarize the lessons learned from our efforts to apply this model. The Institute members will be charged with creating a document summarizing the strengths and weaknesses of our approach and making specific recommendations for broader implementation at other colleges and universities.

Integrating for Excellence: Linking Science and Humanities Honors Courses

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Eastern Kentucky University
Richmond, KY 40475

EW-20125
FY1993 $ 178,200
Science and Humanities

Our proposal addresses two specific problems in our current Honors Program curriculum: 1) How to design a challenging natural science seminar which will be taken by science and non-science majors alike, and 2) How to link this natural science seminar to the humanities and world civilization one-year sequences which precede it in the curriculum and which already are linked to each other.

During the five semesters of the grant project our objectives are to 1) completely redesign the honors natural science seminar so that there are two versions which are challenging to science and non-science majors alike and 2) to modify the existing Honors Program humanities and world civilization one year sequences so as to interrelate and link the content of these courses with the content of the science seminars. This will be done by means of two intensive faculty seminars (May 94 and May 95) for a total of 20 science and humanities faculty.

The first faculty seminar will focus on gaining familiarity with the current content of the humanities and world civilization sequences, and most importantly, on the design of two versions of our honors science seminar. We hope that both versions will contain life science and physical science content and that both will be team taught by one life scientist and one physical scientist. Teaching strategies to engage bright undergraduates will also be discussed.

The second faculty seminar will evaluate the actual teaching of the two science seminars and will explore science/ethics and science/religion issues which might serve as topics of linkage between the humanities and world civilization sequences and the science seminars. Cross-disciplinary understanding will be fostered by faculty master learners in both humanities and science disciplines who take Honors Program courses in each other's fields. A two day evaluation seminar for project participants, with the help of an outside evaluator, will be held in May of 1996. A lecture series by four distinguished scientists and humanists will also take place during the grant period. The personal and professional lives of all four lecturers exemplify science/humanities connections.

We will disseminate the results of our project through joint faculty/student presentations at state, regional and national honors conferences. Our project will directly impact the 40 new students each year who enter our Honors Program. However, structure and content of our curriculum continues to be the subject of serious inquiry from other honors programs in the state and the nation. In addition, our Honors Program is a model on our campus for the kind of integrated core curriculum that could be developed for the regular general education program.

The Border: A Multidisciplinary Approach to Critical Issues of U.S./Mexico Integration

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EW-20152
FY1993 $ 73,000
Science and Humanities

The mutual influence and interdependence of the U.S. and Mexico is nowhere more apparent than along the binational border. Far from being an impermeable barrier, the border is a zone of influence that functions as a seam, making inescapable the economic, demographic, cultural, and environmental influences of each country upon the other. From a policy perspective, the relationship of the U.S. and Mexico looms as one of the most pressing foreign and domestic challenges. From an academic perspective, the region shows clearly the intertwining of economy, culture, and environment. Recognizing that an understanding of such a multi-faceted region as the border demands multidisciplinary pedagogical methods, we will integrate the traditionally separate disciplinary approaches to knowledge of science, social science and the humanities in an innovative program of course development and implementation.

Our objective is to examine critical issues pertaining to the U.S./Mexico border area, and to the larger issues of binational integration, from a truly multidisciplinary perspective; to develop an understanding by students of the border as not just a line on the map but as region, process, and metaphor; to institutionalize a border studies program at Occidental College.

The project will consist of five phases: (1) Planning, in which project leaders, student assistants, and advisory board determine the content and methods of an appropriate class on border issues; (2) teaching, in which student assistants will form part of the teaching team and advisory board members will serve as guest lecturers; (3) evaluation, in which project leaders, teaching assistants, advisory board members, and students who have participated in the course will meet and evaluate the first course and offer suggestions for the future; (4) dissemination, in which project leaders and student assistants will develop a packet of course materials and contact other colleges, particularly community colleges, to offer guest lectures and the course materials so that they can have their own border studies courses; and (5) institutionalization, in which we hope to institutionalize the course at Occidental College.

This project and the course resulting from it, will have a truly multidisciplinary perspective, which we believe is necessary to examine the complex issues of the border area. We hope to institutionalize both this perspective on the border and the view of Los Angeles as part of the border region at Occidental College and beyond.

"Science In Context" Faculty Seminars

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Tacoma, WA 98416

EW-20159
FY1993 $ 143,915
Science and Humanities

In adding a "Science In Context" requirement to its core curriculum, the University of Puget Sound recognizes a national wave of interest in the revitalization of science education and a specific institutional opportunity. Many commentators criticize relatively hidebound methods of teaching science and call for a science-literate citizenry. Students suggest that science requirements often seem unconnected with other spheres of learning. Scholars find it remarkably easy to list realms of human thought, patterns of historical development and pressing contemporary issues requiring an integration of scientific and humanistic ideas for reasoned understanding. However, they find it much more difficult to identify how traditional patterns of education, even in the liberal arts college, promote such integration. The objective at Puget Sound is to change this pattern.

The "Science In Context" requirement emphasizes the connectedness of scientific and humanistic learning by prescribing that both spheres be included substantively within the same course and by specifying that all such courses be developed by teams of faculty representing a number of disciplines. The requirement is to be met by students during their junior year at a point when they will have taken both two required courses in a laboratory science and broader courses in the humanities and social sciences. Faculty teaching the courses and students taking them confront the challenges of working together effectively, of communicating clearly across disciplinary boundaries, and of acknowledging the insights to be gained from perspectives other than those of their own primary fields.

A series of six faculty development seminars will be held during the summer of 1994. Each seminar involves the faculty team for one "Science In Context" course in the preparation of a syllabus and course materials, including an anthology. Consultant visits and evaluation visits are scheduled to occur both during the seminars and while the courses are being taught in the 1994-95 academic year. The University is adding faculty positions in direct support of "Science In Context" courses. Faculty intend to submit the resulting syllabi for publication in appropriate journals or listings and to discuss "Science In Context" results at conferences and meetings. Preliminary contacts exist to allow developed anthologies to be considered for publication.

The University expects through the grant to strengthen its own faculty and curriculum and to provide intellectually challenging, interdisciplinary courses to some 700 students each year. It anticipates as well that fully developed "Science In Context" courses may offer models worthy of study, and perhaps emulation, for other institutions seeking a better integration of science and humanities teaching.

"Global Heritage: A Multi-Disciplinary Focus on Sustainable Development."

K. Khalsa	EW-20179
Thiel College	FY1993 $ 135,000
Greenville, PA 16125	Science and Humanities

The project addresses the curricular need to seriously examine ways in which the rich natural and cultural heritage of the globe can be sustained. The objective is to develop a course, Global Heritage, in which the sciences and the humanities together investigate the theme of sustainable development.

The plan to accomplish this objective covers a period of three years. Activities during this period include: (1) Faculty development for twenty-four faculty members (over one-third of the faculty) that is facilitated and enhanced by seven noted scholars each of whom will make a three-day visit to the campus, (2) design and implementation of a year-long, sophomore-level, laboratory-centered, multi-disciplinary course which will impact upon 240 students during this period and (3) conducting workshops and forums, writing a textbook and laboratory manual, and presenting papers on the project as it progresses.

Evaluation mechanisms include: (1) Qualitative studies of the course development from logs and documents produced in regularly scheduled meetings of the staff, (2) testing of laboratory exercises and other unproved materials in ongoing classes through the developmental year, (3) feedback from the seven consultants to include both voluntary responses and responses to questions solicited by the development team, (4) pre- and post-test evaluations for students in both the pilot group and the integrated course, (5) a yearly assessment from an internal evaluator familiar with the existing curriculum and (6) an outside evaluator who will review the internal studies and provide an external assessment through extensive structured interviews with students, administrators, program faculty and faculty from associated disciplines whose students might be impacted by the course.

Dissemination of the results is to take place on six levels: (1) Global Heritage Lecture Series on Sustainable Development featuring the consultants, to which neighboring colleges and universities will be invited during the faculty development year of the project, (2) seminars with Thiel colleagues in related disciplines, (3) a faculty forum on Global Interdisciplinary Courses to be held at Thiel College for members of the Council of Independent Colleges from the ten-state area, (4) a weekend workshop to be held at Thiel College to which area high school teachers will be invited to attend; (5) interaction among consultants so that they might share their own work regarding our project and, of course, their own respective research, (6) professional presentations in the form of papers or as forum panelists at regional and national conferences with contributions to edited works possibly following these presentations.

The hoped for significance of the project is to develop a unique course that will become a central part of our college's core requirement as a complement to the Western Heritage course that is currently in place. This new course has the potential to transform the ethos of our institution and to help make good the College's goal of fostering an integrative world view. We also hope to lift up to the broader educational community an interdisciplinary course which deals pointedly and coherently with the pressing global issues of our time while providing students with a thorough grounding in the basic principles of the natural sciences.

The Scientific, Ethical, and Social Challenge of Assisted Reproduction

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EW-20122
FY1993 $ 95,000
Science and Humanities

Remarkable developments in the area of assisted reproduction have led to a spirited public debate over the ethical, legal, social and human implications of these new technologies. Among the questions raised by these technologies are whether infertility is a disease appropriately treated by medical means; how the products of human conception should ethically be treated and how our legal and social institutions should respond to a world in which parenthood can take so many biological and social forms. The Ethics Institute at Dartmouth College is developing a sequence of two multidisciplinary courses in this area. These courses, taught by a core faculty with expertise in moral philosophy, religious studies, reproductive biology, psychology, social sciences and women's studies, draw on Dartmouth's special strengths. Among these are a new multidisciplinary curricular requirement, a history of collaborative teaching between undergraduate and professional school faculty and the Dartmouth-Hitchcock Medical Center's well-established clinical program in Assisted Reproduction.

The two courses are designed as model courses in three respects. First, they are exemplary of the kind of multidisciplinary courses called for under Dartmouth's new core curriculum. We instill in students an appreciation for the different and complementary ways the various disciplines approach common issues. Second, these are the first in a series of multidisciplinary courses in science, ethics, and society introduced by Dartmouth's Ethics Institute. Building on current funded work at the Institute, we plan similar multidisciplinary science/humanities courses in the ethics of scientific research and ethical issues raised by human genome research. Third, these two initial courses serve as models for other multidisciplinary undergraduate courses of this genre at Dartmouth and nation-wide. Course evaluation is by pre- and post-test examination to determine the enhancement of both scientific/technical literacy and philosophical concepts.

In addition, students are responsible for an analytical paper involving the moral analysis of a case. Faculty who participate in course development and teaching will also be asked to assess the value and impact of their experience.

Drawing on previous work by other institutions in the ethics of assisted reproduction, we are developing new teaching materials (syllabi; bibliographies; case studies; and evaluative tests) that will in turn enable other institutions, including those lacking Dartmouth's strong clinical resources, to offer challenging courses dealing with these new issues. These materials will be made available at cost to other scholars and institutions as initial offerings in a new Ethics Institute publication/media series, "Dartmouth Teaching Resources in Applied and Professional Ethics."

Curriculum Development in Science & Technology Studies

Sheila S. Jasanoff	EW-20121
Cornell University	FY1993 $ 109,565
Ithaca, NY 148583-2501·	Science and Humanities

Many of the issues that loom largest in public discourse at the end of the 20th century, changes in the global environment, proliferation of nuclear expertise, access to medical care, are simultaneously ethical, political, and technical. Yet failures of communication and understanding between citizens and technical experts appear to grow larger as public investment in science and technology increases. Our project addresses this problem by developing an undergraduate program in the interdisciplinary field of Science and Technology Studies (S&TS).

The program will foster deeper intellectual exchanges between two seemingly disparate groups of undergraduates. For those in the humanities and social sciences, we hope to provide a close and critical encounter with the cultures of science and technology; for undergraduates in the physical sciences and engineering, we will offer analytical perspectives that will aid them in integrating their work into the larger culture of which they are a part.

We are creating three new courses and a faculty training seminar that will furnish our undergraduate majors with a durable core and a richer periphery in their explorations of science and technology. "What is Science" is a required introductory course that will utilize new models of science developed in recent history and sociology of science and feminist theory to present science as a more messy, contingent human activity than that depicted in previously standard accounts. "Science in the American Polity" is a two-semester, required course that synthesizes the history and politics of science and technology to show how they have patterned as constitutive features of the American nation from the founding of the republic to the present. "Atomic Consequences," a model for special-issue courses in the S&TS major, challenges technologically deterministic accounts of the history of atomic power from the Manhattan Project to the fall of the nuclear power industry by viewing the history of technology as a powerful kind of social history. Innovative teaching tools, such as computer-assisted multi-media techniques, are used in order to enrich the students' experience of the varied contexts of the practice of science and technology. The project includes a one-week summer seminar to train science and engineering faculty to address interdisciplinary goals.

After the second year of the project, we plan to invite several prominent scholars from our peer programs in the United States for a two-day meeting to evaluate the project. We expect that the review will assist us not only in making necessary mid-course adjustments, but in disseminating our results to a select audience. In addition to the normal channels of dissemination, such as bulletin boards, newsletters, published articles, and conferences, we hope to make some of our course materials and experiences available over the internet.

In these and other ways, we hope to develop a strong S&TS undergraduate program that will prepare Cornell students to be active citizens in a world increasingly dominated by science and technology.

Interdisciplinary Learning Communities In Humanities, Social Sciences & Natural Science Courses

David Ram	EW-20134
Holyoke Community College	FY1993 $ 106,954
Holyoke, MA 01040	Science and Humanities

While the required core curriculum at Holyoke Community College ensures that students include humanities, social sciences and natural science courses in their program of study, it does not encourage students to explore the relations between the disciplines and transfer their learning from one course to another. In addition, unlike career programs which enable students to develop a strong affinity with their program, their teachers and their classmates, students in the Arts and Science program have little opportunity to develop relationships with one another or with faculty. This project provides liberal arts and science students with an alternative means of satisfying existing core curricula requirements and enables them to examine important issues and problems from a variety of disciplinary perspectives. Integrating the disciplines as learning communities fosters a spirit of community among Arts and Science students and faculty, thus encouraging students to enroll in upper division science and humanities courses.

Over the three-year grant period, 15 faculty will work together as a group and in teams of two or three to develop, test, evaluate and fully implement five learning communities that will serve approximately 300 students. One single section learning community will be created for developmental students and another single section community will be an honors level course. Three multisection learning communities will consist of two or more college level courses. Each learning community will address a specific aspect of a unifying theme allowing the learning communities to gather as a group for presentations by visiting scholars. Initially, faculty will modify existing courses and develop special reading lists and course materials in order to form a learning community which links a humanities course with a social and/or natural science to address a specific theme. In the final year of the project, three learning communities will implement a 6 to 10 credit interdisciplinary course which fulfills core requirements.

Project evaluation is comprehensive, involving qualitative and quantitative research at both the classroom and institutional levels. At the heart of the evaluation effort is faculty designed classroom research which utilizes a variety of methods (e.g., entry/exit performance assessments, student self-assessment, course/instructor evaluation (SGID) and reflective interviews) to gather the qualitative data that will support summative and formative evaluation of the interdisciplinary learning communities and new core curricula courses. Faculty and staff also will gather and analyze quantitative data related to student achievement and student enrollment patterns.

Curriculum and materials developed in conjunction with this project will be disseminated through presentations at regional and national conferences and discipline-related professional journals. The college will produce and disseminate a video presentation on the program as well as a special edition of the Holyoke Community College faculty journal, *The Other Forum*. As a culminating dissemination and collaboration activity, the college will host a conference on interdisciplinary teaching and learning in the final year of the project.

At the conclusion of the project, faculty in the humanities, social sciences and natural sciences will have created a model for interdisciplinary curriculum development and instruction and produced materials that can be replicated at other two-and four-year colleges.

Core Seminars In Environmental Studies

Allie M. Frazier	EW-20133
Hollins College	FY1993 $ 63,574
Roanoke, VA 24020	Science and Humanities

Four core seminars in our new Environmental Studies Pathway (ESP) will be planned and implemented. The Environmental Studies Pathway will provide students with a new way to give coherence and programmatic structure to their elective programs. Each seminar will be interdisciplinary in nature and will be taught by faculty drawn from the natural sciences and the humanities.

The Pathway program seeks to overcome the weakness in a distributional elective program which guarantees that students take a broad range of courses but cannot guarantee that students encounter the interconnectedness of knowledge. Nor can it assure that students confront the task of significant integration of several disciplinary perspectives

The core seminars will demonstrate to students how various disciplines construe problems, themes, and bodies of knowledge. Using faculty from biology, chemistry, philosophy, english, political science, and art, we will create the following seminars: Seminar 1--Nature and the Human; Seminar 2--Environmental Ethics; Seminar 3--The Representation of Nature in Literature and the New Science; Seminar 4-- The Politics of Environmental Responsibility. Each seminar will contain a laboratory component where the method of scientific investigation will be used to extend the inquiry in the seminar.

Eight faculty drawn from the sciences and the humanities will spend six weeks of extensive planning and reading of texts during the summers of 1994-95. Four faculty will plan the syllabi for Seminars 1 and 2 during the summer of 1994. Those seminars will be implemented in 1994-95. The other two Seminars will be planned during the summer of 1995 and implemented in 1995-96.

Four distinguished professors have been identified as consultants and evaluators for the planning process, one for each seminar. In addition, one of the consultants will be asked to evaluate the whole core seminar program.

As a way to give structure and coherence to an elective program, the Environmental Studies Pathway is a rather simple idea that could be introduced in other institutional settings. The director of the program has introduced it at several national conferences. We expect to share our experience with this new model in professional journals and in national meetings.

Integrated Course in Science and Humanities for Elementary Education Majors

Pat Nelson	EW 20176
Susquehanna University	FY 1993 $ 42,644
Selinsgrove, PA 17879	Science and Humanities

A number of reports generated by the National Teachers Association, the Association for the Advancement of Science and Sigma Xi point out a lack of interest and understanding of scientific values in future teachers, communicators and socially concerned citizens. This course seeks to turn this tide by better preparing future teachers to understand and teach the nature of scientific investigations through understanding the important connections between science, history, philosophy and literature.

The objectives of the project are to: 1) Improve the interest and attitude of preservice elementary teachers toward teaching science and 2) improve the ability of future elementary teachers to teach the content and ideas of science through an understanding of the intellectual and historical contexts from which they arose.

This project will develop a fourteen week course for elementary education majors which stresses the integration of content from science and humanities through a series of hands-on activities, practice teaching experiences and accompanying reading material.

A project evaluation team will assess improvement in student attitude toward teaching science as well as increased understanding and knowledge of science and particular concepts in the humanities. Pre- and post-test comparisons, classroom observation, video tape analysis of teaching, surveys and in-depth interviews will be used to collect evaluation data.

Publication and presentation will be made at professional meetings of the National Science Teachers Association, American Educational Research Association and the Association of American Colleges of Teacher Education.

This course will be developed jointly by university science faculty, humanities faculty, education faculty and public school teachers.

A Bioliteracy Laboratory Course to Replace Traditional Non-majors Biology Courses at Colleges and Universities.

Dawn A. Adams, Daniel E.Wivagg	DUE-9254171
Baylor University	FY1993 $ 262,433
Waco, TX 76798-7334	Life Sciences

The "non-majors" biology laboratory course has been substantially revised at Baylor University to include activities shown by recent research to be effective. Methods including cooperative learning, inquiry-based instruction and emphasis on critical thinking and writing have been successful, but problems remain. Interdisciplinary studies, expanded biology experiences, training of teaching assistants, feedback on writing assignments, sensitivity to ethnic and gender differences in learning styles, and structure of the teaching laboratory are all topics that have been identified for further study and improvement. Interdisciplinary work groups are addressing these problems and we are recruiting and supporting exceptional science graduate students who are interested in teaching. Baylor has committed funds for renovation of the laboratory, and a separate grant or corporate partnership will be solicited to improve technology. This innovative curriculum for undergraduate bioliteracy instruction and an intensive program for training of teaching assistants will serve as models for introductory biology education at comprehensive research universities and colleges.

Interactive Hypermedia Experimental Simulations for Introductory Biology and Cell Biology Students

Mark S. Bergland	DUE-9254089
University of Wisconsin River Falls	FY1993 $ 47,927
River Falls, WI 54022	Life Sciences

This project is aimed at helping first and second-year students in Introductory Biology and Cell Biology courses develop the critical thinking skills used by scientific investigators. Hypermedia software is being developed that enables introductory students to simulate actual experimental investigations in cell biology and biotechnology, including patch clamp studies of ion channels in cell membranes and the micro manipulation of transgenic embryos used to create animal models for AIDS research. Students can generate data and make inferences from these data. The simulations are planned to: (1) complement existing laboratories in Introductory Biology with experimental procedures that are otherwise not feasible in this course, (2) enrich and expand those Cell Biology laboratories which do give students hands-on experience with at least some of the simulated procedures, (3) prepare students for the advanced Molecular Biology course which includes the actual manipulation of embryos used in transgenic animal production, and (4) serve as a recruitment tool for the Biology major and also for the new interdisciplinary Biotechnology major at UW-River Falls. A controlled statistical study is evaluating the long-term impact of this project and results will be disseminated via workshops and presentations to educational organizations.

Introductory Course to Teach Methods in Environmental Science

Michele M. Hluchy, Gordon L. Godshalk,	DUE-9254104
James F. Curl	FY1993 $ 73,638
Alfred University	Life Sciences
Alfred, NY 14802	

"Methods in Environmental Science," is being offered to freshmen and sophomores of all majors at Alfred University. The primary emphasis of this new course is on introducing students to how science is performed by supervising their research as class projects in ozone monitoring, geotechnical evaluation, and evaluation of discharge and pollution of surface and ground waters. Juniors and seniors in Environmental Studies are used as mentors in the class to encourage and prepare them for future teaching careers. A graduate student in education assists and receives instruction while practicing teaching in a science. The course is specifically designed to overcome many contemporary criticisms of science education by assuring that students are introduced to science as a process. Heavy emphasis is being placed on quantitative skills integrating use of mathematics and computers into science.

Integrating Three-dimensional Computer Generated Animations into a Multimedia-based Hypermedia System for Introductory Biology

Carey R. Phillips	DUE-9254263
Bowdoin College	FY1993 $ 125,000
Brunswick, ME 04011	Life Sciences

Students have a difficult time visualizing complex biological structures and understanding how the shapes of these structures relate to their function. This is especially true when a number of structures are spatially integrated in order to produce a single function or complex changes in shape are necessary to perform a function.

To address this problem, three-dimensional models of biological structures are being animated and rendered onto video format. Text descriptions of the objects and events occurring within the animation are linked via a hypermedia system to provide additional information about these structures and events as requested by the student. Various other forms of related information such as time lapse video, electron micro graphs, serial sections etc., are also available to the student within the hypermedia framework. During the grant period a three-dimensional model of a cell and its organelles is being created, and an animation of a journey around each organelle within the cell is being linked through a hypermedia system to a text description of each structure or event. Also an animation depicting gametogenesis and fertilization is being produced and linked to text descriptions and other related media forms through a hypermedia system. The animations and related media data bases are being used in teaching Introductory Biology and Developmental Biology.

The ability of students to conceptualize and utilize the information presented by the animation/hypermedia format will be evaluated by comparison with student progress from previous years. Students will also be examined on their ability to visualize the spatial relationships of cellular components as they relate to biological events.

The animations will be made available to other institutions by distributions on CDs and made compatible with available hypermedia systems. The animations will also be used as demonstrations in local high school and middle school science classes. The teachers of these classes will evaluate the use of this technology to interest and stimulate students in the secondary education system. It is hoped that three-dimensional animations will provide students with a much better view of the structure and dynamic nature of biology. It is also hoped that the use of the additional information sources through the hypermedia will encourage students, of all ages, to ask questions and learn to investigate in a very non-threatening and personal environment.

A Slice of Life: An Introductory Biology Course

Diane Ebert-May, Jay S. Tashiro	DUE-9254280
Northern Arizona University	FY1993 $ 303,145
Flagstaff, AZ 86011	FY1994 $ 100,000
	Life Sciences

This project is designed to increase the scientific literacy of undergraduate non-majors at Northern Arizona University and community colleges in Arizona with predominantly ethnic minority populations, Navajo Community College, Pima Community College, and Cochise Community College.

The project has four major foci: (1) We are restructing an introductory biology course for non-majors so that it enhances students' scientific literacy and their understanding of multidisciplinary approaches to real-world problems. The laboratory component for the course provides students the opportunity to do inquiry-based and research-oriented science. (2) We are effecting systemic change at NAU and the three community colleges by developing and implementing professional development seminars and practical workshops for graduate teaching assistants and faculty. These workshops explore new approaches to developing relevant and substantive curricular frameworks for introductory biology for non-majors. (3) We are testing the restructuring of introductory biology through an experimental design that enables us to determine what is the most effective design for two kinds of academic communities, a state comprehensive university and a sample of community colleges in Arizona. (4) We are following faculty and their students in a longitudinal study of the course's impacts. Our project represents an experimental approach to curriculum development that will determine "what works" in non-majors biology courses.

An Enhanced Bioscience Education Program for the Introductory Years of the Biology Major and for Interested Future teachers

Wayne E. Magee, Bernard P. Sagik,	DUE 9253994
Presley F. Martin	FY1993 $ 269,266
Drexel University	Life Sciences
Philadelphia, PA 19104	

The Enhanced Bioscience Education program greatly increases the effectiveness of undergraduate education in the biological sciences. The new integrated curriculum presents science as it is practiced as a problem-solving, investigative activity. The curriculum is designed for up to 100 bioscience and teacher preparation majors. It is organized around topic areas and extends over five quarters of instruction: (1) Biological Investigation is the heart of the curriculum and consists of a series of laboratory modules covering the important concepts of modern biology, leading students toward design of their own experiments. There is a strong emphasis on use of computers for collecting data and for data analysis and interpretation. (2) Principals of Bioscience includes the content areas now covered in freshman biology, cell physiology, microbiology and genetics presented as a single, coherent sequence and completely integrated with Biological Investigation laboratories. (3) Physical Sciences and Mathematics covers the topics of freshman and sophomore chemistry, mathematics and physics, with the appropriate information and skills introduced in the order needed. An Undergraduate Research Program includes freshman and sophomore independent research projects, preparation for more advanced projects, and the establishment of the Drexel Journal of Undergraduate Research as a vehicle for dissemination of student research. Special attention is paid to problems of student support and retention. Specific plans are included for evaluation and effective dissemination of the outcomes of the project.

Science and Language: A Transitional and Integrative Approach to the Learning of Science by Female, Adult African-American Students

Charlotte A. Zalewsky, Elaine O. Lees	DUE-9254215
Carlow College	FY1993 $ 119,622
Pittsburgh, PA 15213	Life Sciences

This project is designed to address the needs of African-American women who do poorly in science upon entering the academic world. Students in the Program, which targets disadvantaged minority women in Pittsburgh, often find science courses a roadblock in their academic path and a place for failure. Despite a high level of motivation and eagerness to succeed in science, many students struggle with the combined effects of inadequate science study skills, years of separation from secondary math and science courses, and a lack of confidence. Yet these students have ability and the potential to pursue careers in science. A specific objective of the project includes designing a "Science and Language" course that 1) examines science in a non-traditional way by integrating a 4-credit science class with a 3-credit writing class so that students use writing as a tool to learn science and use science as the content in developing writing skills; 2) facilitates students' transition between previous course work and their study of science; 3) maximizes connections among science principles, real-life situations, and issues familiar to African-American women; 4) engages students in designing their own experiments; 5) engages students in collaborative teaching and peer tutoring experiences in which they learn as teachers of the content; and 6) creates a partnership between students and instructors that provides flexibility in designing approaches to learning. The project's objectives are: 1) to design Biology Study Groups modeled after those of Uri Treisman in math to further integrate the course's content and foster an experience of an academic science community; 2) to design a "safety net" of tutorial support involving Carlow's Learning Center and Hill College's new Peer Tutoring Program, and 3) to collect data for evaluation.

The planned Science and Language course begins by helping students eliminate barriers such as anxiety as they become conversant with science through reviewing a science-fiction film, analyzing a report on the state of science education in the U.S. and examining essays and texts related to science. In the writing class, students explore the investigative nature of science, the human element of science and science as language through reading and discussions, written summaries, outlines, abstracts, essays and lab reports. On-going science classes and laboratories parallel the ongoing writing class. The science half of the class requires student participation and student-designed experiments with de-emphasis on canned labs and instructor-dominated lectures. Students study major themes in Natural Science such as DNA and heredity, interdependence and ecology, diversity and evolution.

Assessment and evaluation are given the highest priority in the project. Activities include 1) monitoring the program as it is implemented with data collected regarding student attendance, participation, success of study groups, etc., and 2) assessment of included taped interviews, student's before and after completion of the course to determine impact in the areas of self-esteem, reasoning ability, and academic performance. Additional data will be collected regarding demographic characteristics of the students (age, race, number of children, etc.) and academic background.

Planned dissemination of results include local, regional and national presentations and conferences; publications and informal hosting of teachers of science at the College to observe the courses. The Science and Language course is a proposed solution to reverse the failure of African-American adult women in introductory science. It pulls together what is known about how to teach science, how students best learn science and our own experiences in teaching it, with the goal of offering a multifaceted approach for success. If this course "works" it opens the door to science for majors and non-majors and can serve as a model for students failing in science. The model itself can be easily adapted to other institutions and implemented without excessive cost or dependence on Federal funding.

Reducing Roadblocks to Learning in Introductory Biology: A Computer-Module Development Project

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Meadville, PA 16335

DUE-9254168
FY1993 $ 101,010
Life Sciences

This project addresses the overall problem of keeping students in the science pipeline. The Biology Department faculty are providing computerized pre-laboratory exercises that involve students in the challenge and excitement of scientific investigation and discovery. Specifically, our project addresses common "roadblocks" to learning faced by biology students, such as: limitations of time and finances on the laboratory experience, a lack of understanding of the scientific process, a lack of analytical, critical thinking, and quantitative skills, differing cognitive styles, and a lack of comfort with advanced technology. Project objectives include: 1) development and refinement of computer-based applications, such as experiment simulations, systems models, data collection and analysis tools and visual image libraries of organisms, preparations and dissections; 2) Expanding the faculty's use of investigative laboratory activities; students will be expected to design experiments, execute them, analyze data collected, and draw conclusions and generate ideas for further investigations; and 3) utilizing the talents and experience of advanced-level biology students to help faculty develop and test computer applications for introductory labs, and to work with underclassmen on their laboratory and independent investigations.

Working with the College's Educational Computing Services, a group of six biology faculty, each of whom has release time, are developing 12 pre-laboratory computer modules. They are using the multi-media, multi-tasking capacity of the NEXT computer workstation and the Next Step development environment to create lessons specifically designed to meet the needs of students in the three introductory biology courses. Advanced-level students are taking advantage of Next Step development workshops held on campus so that they can assist faculty in applications development. They also assist the faculty in the labs.

Formative and summative evaluation tools are being used to assess the effectiveness of this project. An 'Advisory Board' comprised of biologists from other institutions will meet at least yearly, to monitor the program and determine whether parts of the program ought to be redirected, replaced or augmented. A summative evaluation will be conducted by this Board and by the Allegheny faculty. Final project results will be disseminated to the Advisory Board and to other colleagues nationwide. A symposium to mark the opening of its Hall of Advanced Biology at Allegheny College features this project and other advances in the educational uses of computing technology.

This project will help our students to discover the excitement of science and it will also help Biology Departments at other colleges which use Unix-based workstations. Colleges that do not use Unix-based workstations can emulate Allegheny's approach by identifying roadblocks to learning and addressing them through interactive computer lessons.

A Multimedia Plant Science Laboratory

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Blacksburg, VA 24061

DUE-9254295
FY1993 $ 99,986
FY1994 $ 74,054
Life Sciences

Laboratory software modules, linked to a videodisk of still, motion and animation sequences, are being used in a new undergraduate plant science lab. We are linking the laboratory computers in a local area network so that groups of students can communicate with other groups (and with the teaching assistant) in order to work on open-ended, thought-provoking exercises in a cooperative, collaborative learning environment of scientific discourse and debate. We are also testing the new and existing modules and exercises to assess the changes in the teaching/learning process that occur upon adoption of this new educational technology.

A core of 15 multimedia lab modules has been produced through collaboration of VPI Learning Research Center and the Department of Biology. This core material lacks self-help tutorials to guide students through its complex new format, which shifts the traditional lab goal of demonstration to one of understanding causal relations and interconnectedness. We use ecology and evolution as major themes to interpret plant construction, growth, and development, reproduction, and grouping.

We are developing the self-help tutorials and cooperative learning exercises for the 15 core modules, producing alternatives for several of them, implementing the local area network, and designing and implementing assessment instruments to analyze our software modules and the changes in teaching/learning that this new educational technology brings to the life sciences.

Computer Applications to Enhance Inquiry-Oriented Laboratory Instruction in Biology at a 2-Year College

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Flagstaff, AZ 86002-3349

DUE-9254228
FY1993 $ 132,180
FY1994 $ 82,125
FY1995 $ 83,177
Life Sciences

We are addressing the general problem of scientific and technical literacy and specifically the enhancement of inquiry-oriented laboratory instruction in biology. Our goals are to increase scientific literacy, reasoning skills, and the number of students succeeding in our introductory biology courses. To achieve these goals we are developing, evaluating and integrating into the curriculum a set of computer applications designed to reinforce biology concepts introduced in exploratory lab activities and integrate the reasoning skills for the use in new contexts. Our efforts are focused on an introductory biology course at a 2-year college that serves a nontraditional undergraduate population. That is, a student population including relatively more women, Hispanics, Native Americans and relatively older students. We also serve a large transfer and reserve transfer population associated with a nearby comprehensive university. As a result of our instructional intervention, we predict that our classes will have improved biology achievement, scientific reasoning skills, attitudes toward science, retention of underrepresented student populations, computer literacy and instructor efficiency and effectiveness. Our results will document the efficacy of a refinement to inquiry-oriented laboratory instruction and provide a model for the use of technology in education.

Conference on "Strategies for Teaching the Life Sciences to Undergraduates"

Sharon L. Zablotney	DUE-9353342
American Society for Microbiology	FY1993 $ 8,820
Washington, DC 20006	Life Sciences

To catalyze improvements in teaching and learning in the life sciences at the undergraduate level a conference, sponsored by the Coalition for Education in the Life Sciences (CELS), is being held at the Marine Biological Laboratory in Woods Hole, MA from February 14-17, 1993. About 150 participants will consider effective teaching models and relate these models to changes in student assessment. Plenary topics include: 1) how biology can contribute to literacy and liberal education, 2) coping with the diverse field of biology, 3) developing an effective institutional plan for change at small and large institutions, 4) linkage to the life sciences education clearinghouse, and 5) a training workshop that will provide information about how to get educational sessions incorporated as part of the regular meetings of professional societies. A Proceedings is planned that will contain the abstracts of contributions and summaries of the plenary sessions. This award is to support the production and dissemination of the Proceedings.

Introductory Undergraduate Sequence in Environmental Science and Policy

Norman L. Christensen, Richard A. White	DUE-9156089
Duke University	FY 1992 $ 115,516
Durham, NC 27706	FY 1993 $ 116,473
	Life Sciences

Duke University is developing a model introductory course sequence for its new interdisciplinary undergraduate Program in Environmental Sciences and Policy. Duke University recognizes the need to increase the awareness and understanding of environmental issues among all students regardless of career plans. Duke also realizes the need to recruit increasing numbers of students, particularly women and underrepresented groups, into the sciences and into scientific teaching and research careers.

Specifically, we are expanding the University's Freshman Seminar Program to introduce both non-majors and potential majors to topics in the environment, to increase basic literacy in science and environmental issues and to promote a concerned and informed citizenry. We are also developing a one semester core course for our new Environmental Sciences and Policy major that increases direct involvement of students through experiential learning and case studies, and serves as a model for introductory courses in other disciplines. Through the development of a model introductory course sequence, we seek to prepare students for leadership roles in careers bridging the natural and social sciences. We also want to provide a forum for faculty discussion of teaching methodologies and the development of appropriate reward mechanisms for quality teaching parallel to research.

Because our principle goal is to improve the University's overall science curriculum, we are concentrating both on how faculty can teach and how students can learn more effectively. Advanced undergraduate Research Apprentices and graduate Teaching Assistants are assisting faculty with the development and implementation of both course materials for the freshman seminars and case studies for the one-semester introductory core course in the Environmental Sciences and Policy major. To enable instructors to concentrate on the learner and the learning environment, we are encouraging formative evaluation of our program from the outset. Dr. Leonard Barry, Provost and Vice President of Florida Atlantic University, plans several site visits to meet with faculty, graduate Teaching Assistants and undergraduate Research Apprentices to assess the appropriateness of course models and case histories being developed for classroom instruction. Dr. Barry is also working with our Director of Undergraduate Studies, Dr. Randall Kramer, and faculty/student teams to develop survey instruments that can be given to undergraduates enrolling in freshman seminars or the introductory core course as a means of evaluating the impact of course materials and classroom instruction.

The School of the Environment is currently discussing with the Duke University Press publications for distribution of case studies and course related materials. We are also investigating opportunities for dissemination through audiovisual and interactive video technologies and are exploring possible linkages with Public Television, The Discovery Channel, and other corporate partners. We believe that we can have an immediate impact on undergraduate science education at sister institutions in the Carolina-Ohio Science Education Network (COSEN) through the dissemination of publications and course manuals. Moreover, it is our desire eventually to develop models and materials in partnership with these institutions that can be used to improve science education, particularly for young women and underrepresented groups, at the K12 level.

Undergraduate Biotechnology Curriculum Development Project

Jack C. Chirikjian, Karen M. Graf	DUE-9245304
Georgetown University	FY 1991 $ 118,000
Washington, DC 20057	FY 1992 $ 118,000
	FY 1993 $ 15,000
	Life Sciences

Because of the multidisciplinary nature of biotechnology, its incorporation into existing undergraduate introductory science courses, such as biology and chemistry, can contribute to the enrichment of these courses and also help to demonstrate lateral and horizontal connections between sciences which have been traditionally perceived as distinctly independent scientific disciplines. The project outlines a strategy for the development of high-quality, creative curriculum models which place emphasis on transferring basic core technology (theory, research, and experimental procedures) utilized in biotechnology and adapts these models to fit within the structure of the educational setting. The primary focus of these curriculum models is to incorporate core technology, through theory and hands-on experiments within a context that directly correlates and demonstrates relationships to recent developments in and applications of biotechnology in such areas as medicine, agriculture, forensics and industrial procedures and processes. Faculty participants are developing curriculum modules which will be implemented and field-tested at their respective colleges. Based upon field-test evaluations, the curriculum modules will be refined, modified, and reimplemented, and will provide the basis for the development of a biotechnology curriculum and resource manual for widespread dissemination to undergraduate faculty. The project's overall strategy strives to help promote scientific literacy to aid students in making important future decisions which will affect their personal lives, as well as stimulate and influence some students to continue in scientific studies.

The BioQUEST Learning Tools Development Project

John R. Jungck, James H. Stewart	DUE-9155885
Beloit College	FY 1992 $ 114,804
Beloit, WI 53511	FY 1993 $ 52,551
	Life Sciences

The purpose of this project is to promote: (1) curriculum and instructional materials development, (2) materials dissemination and (3) the establishment and maintenance of a viable communication network among biologists, science educators, software developers, and other interested individuals. A summer workshop will be held to promote the development of materials that support BioQUEST's problem solving, long-term research approach to the teaching and learning of biology (the "3P's" approach: problem-posing, problem-solving, and peer persuasion). Participants are invited based on their commitment to creating and implementing open-ended, investigative materials for learning, diversity of campuses and student populations, innovative teaching and expertise in topic areas. Two-thirds of the participants develop materials with a view toward addressing the implementation of the BioQUEST 3P's approach to the teaching and learning of biology and the use of computer tools and simulations in undergraduate biology education. Participants are surveyed in advance to determine what projects they will work on at the workshop and to ensure that they will be able to arrive prepared to begin work on that project. Development occurs with attention to the diversity of two- and four-year undergraduate campuses regarding such issues as class size, availability of laboratory computer equipment and supplies, student assessment and transferability to real world issues. These materials should reduce the considerable time, energy, and expense that is associated with curriculum innovation and reform. An outside evaluator is collecting and assessing data in regards to student learning and the effectiveness of the curricular changes that will occur at selected test site campuses around the nation. The remaining one-third of the workshop participants are primarily concerned with initiating the development of new projects in content areas where software tools and simulations would enhance the teaching of undergraduate biology. The participants establishing these new projects plan both the scope of the project and how they will seek funding to complete the project. The materials developed in these projects may ultimately become part of the growing BioQUEST Library of materials. In addition to materials development, each participant plays a role in the dissemination process by either giving a convention presentation, conducting a local workshop, writing an article for submission to a journal, or utilizing other forms of publication. This approach to dissemination reaches a variety of communities within the broad areas of science, education, and computer science.

Diversity: Science as a Way of Knowing Symposium

M. Patricia Morse, Barbara L. Thorne	DUE-9340004
American Society of Zoologists	FY1992 $ 2,424
Chicago, IL 60680	FY1993 $ 20,000
	Life Sciences

A symposium was held as part of the annual meeting of the American Society of Zoologists in Vancouver, B.C., December 27-30, 1992, on the topic of Biodiversity and the proceedings to be published can be used to develop curricula in biodiversity for entry-level courses in colleges and universities. "The Science As A Way Of Knowing" (SAAWOK) series is targeted to those who teach first-year biology courses in colleges and universities and is sponsored by the Education Committee of ASZ. Goals of SAAWOK are to encourage teachers to: 1) emphasize the concepts of biology in entry-level courses, 2) relate how scientific procedures lead to a better understanding of the natural world and to the solution of many important human problems and 3) present biology as a relevant human discipline. The specific aims of this SAAWOK symposium are: 1) presenting a symposium on a timely topic, Biodiversity, 2) providing hands-on curricular materials on Biodiversity including symposium proceedings, overheads and slides, and essays to the participating teachers and 3) disseminating these materials on a worldwide basis. Participants included ASZ registrants as well as college, university and high school teachers from the Northwest U.S. and Canada who were invited to register at a reduced fee. Materials were preprinted and distributed at the symposium and the symposium proceedings will be published in the American Zoologist.

MATHEMATICS

Mathematics Across the Curriculum

Chaitan P. Gupta, Carol B. Olmstead,
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DUE-9254243
FY1993 $ 50,000
Mathematics

Initial work is underway with the eventual goal of integrating a significant mathematics component into all the core curriculum (or general education) classes at the University of Nevada, Reno. Since all undergraduate students on campus are required to take a selection of these core courses, the program affects everyone.

The problem being addressed is that students arrive on campus with a weak mathematics background and are often exposed to mathematics in one or two "math classes" that are perceived as simply an obstacle to getting a degree. By implementing mathematics throughout the core curriculum, this project is attempting to change this.

Support from this grant enables a total of sixteen faculty, from a variety of disciplines, including mathematics, to develop materials for mathematics in the core courses and determine specific settings where it can be introduced.

A successful Writing Center was implemented in 1989 to facilitate the introduction of a writing component into the core courses (Writing Across the Curriculum). A similar Mathematics Center is being established to support Mathematics Across the Curriculum. The director of the Center is working with faculty to develop curriculum. In addition, student "Math Mentors" are employed and trained by the Center to assist faculty and students in the effective application of mathematics in non-mathematics courses.

It is hoped that in a few years these efforts will help alleviate "math anxiety" and break down barriers to technical careers. The curriculum materials that are being developed will be made available to other institutions. Some support for this project is also being provided by a Hughes Foundation grant.

A Laboratory Approach to Introductory Differential Geometry

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DUE-9254322
FY1993 $ 99,787
Mathematics

Differential geometry of curves and surfaces has an important role in solidifying the standard courses in beginning calculus and linear algebra. The topic provides the tools for visualization of geometric phenomena and for applications to physics, engineering, computer science, and other areas of mathematics. The subject is particularly well-suited to interactive computer graphics. In this project, a complete set of transportable, interactive computer graphics laboratory modules is being developed. The materials can be used to supplement standard courses in calculus and linear algebra, or to supplement a standard textbook in elementary differential geometry. The materials can also provide the foundation on which to build a laboratory intensive differential geometry course. Innovations include the use of new "hypertext" tools for interaction and response, and the use of computer graphics to enhance the visualization experience. Each module presents a single topic or related topics, illustrated by examples that can be modified by students in response to questions and suggestions. The modules are written in a demonstration-investigative mode, well suited for cooperative and collaborative activities. The target student audience includes students considering concentrations in mathematics, physics, engineering, and computer science.

Geometry and the Art of Design

Clare Johnson	DUE-9254120
SUNY Fashion Institute of Technology	FY1993 $ 35,390
New York, NY 10001	Mathematics

Through this project an interdisciplinary course in geometry and design is being created. The primary objective of the project is to address a major challenge in mathematics education for undergraduates by creating a course, innovative in content and structure, that demonstrates to art and design majors the links between artistic creativity and logical processes of mathematics. The course uses geometrical ideas as the organizing force which links scientific, artistic, and cultural subject areas.

The course exposes students to new processes of reasoning and makes them aware of the possibilities that can arise through radical thinking and risk taking; it bridges the apparent gap between the realm of art and design and that of mathematics. The process of awakening students to their creative potential by allowing them to work with unfamiliar reasoning processes widens their horizons and give them skills in new areas. Students have the opportunity to test out the effectiveness of the concepts they develop and bear witness to the reaction of a public-at-large to their experimental efforts.

The materials developed for this course are being tested at several sites in courses for liberal arts majors as well as for students of art and design, and an advisory board is assisting in their evaluation.

An Inquiry-Discovery Integrated Mathematics/Science Course with a Teacher-Training Component

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DUE-9254178
FY1993 $ 172,858
Mathematics

Lehman College is addressing the problem of poor student preparation and the alienation of incoming students from mathematics and science by converting the present core sequence required of incoming students (quantitative reasoning and natural sciences) to a two-semester combined mathematics-science course based on the inquiry-discovery method. A series of laboratory experiences are being developed or adapted from existing material developed by Kolodyi and Epstein in which students are given tasks requiring progressively higher level thinking without getting explicit directions on how to do them. Students keep (and submit) a notebook describing how they do these tasks. Students work in small groups and with tutors to discuss their plans with them and give guidance without actually giving directions. The tutors are science education students taking a specially-designed advanced education course in which they perform the tasks themselves, and then discuss their experiences with the professor. All students in the course, and a large control group outside the course, are given a test of cognitive level at the start of the semester. A test of cognitive ability developed by outside evaluators is given to both groups, and subsequent academic progress of both groups are monitored and compared. Results will be reported at meetings of the Association for the Education of Teachers of Science, National Association for Research in Science Teaching, and National Science Teachers Association, and submitted to the journals of these organizations for publication.

Realizing the Power of Computers in Business Statistics Instruction: A Next Step

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DUE-9254182
FY1993 $ 60,029
Mathematics

This project uses the power of modern computers in the classroom to motivate, interest, and engage students who are taking a required course in business statistics. Although most universities use computers in introductory statistics courses, they are generally used to perform calculations for statistics lab assignments. This project uses the computer to demonstrate statistical concepts using computer graphics in the classroom and not to just perform calculations. Visualization is being used to help convey complex information. This project is expected to enhance students' quantitative reasoning as well as problem solving skills.

To reach these goals six "Visual Basic" computer modules are being developed that use quality color graphics, simulation, and intensive computation within the Microsoft Windows environment to illustrate and demonstrate selected statistical concepts which cannot be elucidated at the chalkboard or using standard statistical packages. Each computer-based module contains lecture materials, learning objectives, case studies, and suggested demonstrations all presented using hypertext documentation. The modules acquaint students with statistical concepts in several ways. First, all modules allow the instructor within the classroom to demonstrate concepts to students while the instructor controls the factors surrounding the concept. Students can also use the demonstration to increase their own understanding of the concepts. Second, in some modules the instructor can use simulation or experimentation to further illustrate the concepts. Third, in other modules, the instructor can use real world data to show how the concept is employed in real, interesting, and diverse situations within business.

Potential impacts include improved student performance, an increase in students' abilities to use statistics to formulate and answer original questions, and enhanced students interest in quantitatively-oriented business careers. These potential impacts will be measured in three separate ways. First, pre and post tests of statistical concepts are given to all business statistics classes within the university (both control and treatment groups). Second, a student evaluation of the modules is administered. Third, one year after graduation students will be sent a questionnaire regarding their impressions of the modules. In addition, a panel of outside peer reviewers has agreed to evaluate the modules at various stages of their development.

The results of this project should be of interest to instructors of business statistics at universities, and four year colleges, and two-year colleges throughout the nation. In order to disseminate these results to the widest possible audience, papers will be presented at the American Statistical Association meetings in 1994 as well as at a quality control conference at Oakland University in 1993. Written papers describing findings will be submitted to appropriate refereed journals.

A Redesign of the College Algebra Course

Linda A. Kime, Judith A. Clark	DUE-9254117
University Massachusetts-Boston	FY1993 $ 206,097
Boston, MA 02125	Mathematics

A cross disciplinary team from the University of Massachusetts at Boston is developing a new approach to the introductory college algebra course. The National Research Council (NRC) has identified undergraduate mathematics curriculum development as the linchpin of mathematics education reform efforts. College algebra has one of the largest undergraduate mathematics enrollments nationally, including a disproportionately large number of women and underrepresented minorities. It is often the first and only mathematics course taken by many undergraduates, including prospective teachers. Rather than encouraging, it too often serves to discourage students from pursuing paths that emphasize quantitative skills. Thus it is a critical target for reform.

This project is developing, implementing, evaluating, and disseminating a new approach to introductory college algebra, designed to increase enthusiasm for and competence in quantitative reasoning. It will cover approximately 80% of the traditional materials and leave students prepared for subsequent mathematics courses. It approaches the topics in a nontraditional way, with a particular focus on mathematical reasoning, problem solving, and communication, as recommended by the NRC and the National Council of Teachers of Mathematics (NCTM). The course is computer based and requires access to a spreadsheet and function graphing program. The materials themselves are machine and software independent. Students work in small groups, using algebraic and technological tools to work on open-ended questions based on real world data and physical phenomena. Half the course is from a social science point of view, half from a "hard" science viewpoint, using topics in astronomy, physics, and the life sciences.

Formative evaluation is being accomplished by using teams to simultaneously co-teach and develop the course, by student responses and writings, by tracking students through subsequent placement tests and quantitative courses, and by feedback by outside reviewers. An outside evaluator will provide a summative evaluation.

UMass/Boston is an urban, commuter, comprehensive university with the highest percentage of minority students of any college or university in New England. The project team is collaborating with several other institutions in the greater Boston area, including Roxbory Community College, an historically black college.

This project is designed to aid in the revitalization of undergraduate mathematics teaching by providing a successful model for the redesign of the traditional college algebra course.

Curriculum and Pedagogy Reform in the First Two Years of College Mathematics: Moving Beyond Myths to Standards

Marilyn E. Mays, Dale Ewen,	DUE-9255850
Karen Sharp	FY1993 $ 80,515
AMATYC	Mathematics
Memphis State Technical College	
Memphis, Tennessee 38134	

The recent focus in the mathematical community on calculus and the development of the NCTM Standards for K-12 teachers is providing a framework to consider mathematics courses taught at two-year colleges and lower division mathematics courses taught at other institutions of higher education in this country. These courses are important elements in continuum and pipeline issues, as well as general mathematical needs of students not continuing in mathematically oriented fields of studies. The American Mathematical Association of Two-Year Colleges (AMATYC) is undertaking a leadership role in designing a framework for systemic reform of college mathematics in the curriculum leading to calculus. The first stage is a meeting of an AMATYC National Steering Committee consisting of leaders of AMATYC and other mathematical societies actively involved in the development of innovative mathematics curricula and Standards particularly at the undergraduate level. In the second stage a small invited conference of a National Task Force is being held to establish guidelines for the development of a set of Standards for two-year college and lower division mathematics and to formulate a plan to build consensus for mathematics reform among two-year college and university constituencies. These standards are being disseminated and discussed at national meetings of the mathematical societies and revised based on feedback from this community.

A Modular and Project-Based Statistics Curriculum

Joseph D. Petruccelli, Balgobin Nandram,	DUE-9254087
Mei-Hui Guo	FY1993 $ 165,000
Worcester Polytechnic Institute	Mathematics
Worcester, MA 01609	

This project begins with the premise that the ability to think statistically is an essential component of an educated twenty-first century citizenry. For technical specialists even deeper statistical knowledge is fundamental. Current introductory college statistics courses overwhelmingly focus on teaching statistics as a set of outmoded and arcane formulas divorced from application. There is an urgent need for courses that teach statistical thinking as a process for drawing conclusions in the presence of uncertainty.

The objective of this project is to develop a new introductory statistics curriculum for science, engineering and management students at WPI that can serve as a model for such curricula nationwide. Focusing on the goals of teaching students to think critically about data and having them experience the role of statistics in scientific investigation, the curriculum has among its features: division of the material into one-week modules, each based on a laboratory and project experience, a complete restructuring of course content emphasizing exploratory, graphical, and computational approaches to data analysis and inference; and the incorporation of alternative teaching strategies such as cooperative learning. The modular course structure allows flexibility in customizing the course to student and instructor needs, and ensures portability to other institutions. The labs and projects provide students with hands-on experience in using statistical methods in scientific experimentation, data production, and data analysis. Initial curriculum development of materials is scheduled for January through August 1993. Pilot sections featuring the new curriculum run parallel to regular sections of the introductory course during the 1993-94 academic year. The course is subject to continuous revision and evaluation during piloting and revised again during the summer of 1994 before being offered as a regular course in the 1994-95 academic year.

Project materials being developed include student handouts and instructor guides for each module, lab, and project; computer macros; data sets and evaluation instruments. There is an advisory panel of statisticians and educators to review all project materials prior to and after piloting. Evaluation of course content and materials take, place during development and piloting. Evaluation of course delivery and the impact on students is to be done during piloting, with the latter evaluations using students in the parallel sections as controls.

Dissemination of results is anticipated by presentations at regional and national meetings and workshops on statistics education and curriculum development, and by publication of journal articles describing the project and its results. The project is provides a setting for trying new and innovative approaches to the course content and delivery of introductory statistics at the college level.

Snapshots of Applications in Mathematics

Dennis Callas	DUE-9254326
SUNY Technical Delhi	FY1993 $ 63,000
Delhi, NY 13753-1190	Mathematics

In this project at least 100 short case studies or mathematical "snapshots" are being created. Each is designed to encourage appreciation of mathematics among under-achieving and under-motivated students. Following the compilation of these modules involving substantial library research and industry support, they are being class tested at several institutions.

The project's short case studies differ from existing case studies (UMAP, C0MAP, etc.). They require few prerequisites, are shorter, rely mainly upon oral presentation by instructors, and are adaptable to a broad range of textbooks. They are supplements to existing course work designed to motivate student interest in the subject matter and to show its relevance. Among the studies' goals is highlighting contributions of under-represented groups, thereby providing role models for students.

The project is based upon preliminary work which yielded promising results. The studies are being drawn from a broad range of fields, all highlighting a "snapshot" of applied mathematics. After classroom testing, the project concept and results will be disseminated by a regional seminar. During this seminar, not only will participating instructors learn about the project and receive a booklet containing the developed modules, but these faculty will also be provided the skills and knowledge necessary to design and implement studies for their classrooms.

The Multicultural Mathematics Project

Alverna M. Champion	DUE-9254046
Grand Valley State University	FY1993 $ 81,550
Allendale, MI 49401	Mathematics

The Multicultural Mathematics Project (McMath) is developing an introductory, general education course in geometry. The course uses architecture--particularly the architectural constructions of the dwelling places of various cultural and social groups--as a vehicle to link the discipline of mathematics with the disciplines of physics, engineering, urban geography, and anthropology. The course fosters multicultural understanding in its exploration of the cultural embodiement of mathematics as reflected in the dwelling places of diverse groups of people. Instructors employ multiple teaching strategies as a response to diverse ways of learning, in order to encourage the academic achievement of all students, both those who have had prior success in mathematics and those who have not. Course materials are being piloted and evaluated both by the development team and by an outside evaluator.

Filling the Tank: The Math Modeling/Precalculus Reform Project

Sheldon P. Gordon, Bernard A. Fusaro	DUE-9254085
SUNY Suffolk County Community College	FY1993 $ 149,917
Selden, NY 11784	Mathematics

Materials are being developed for an innovative course in mathematical applications as a modern replacement for existing precalculus and related courses. The course is an introduction to mathematical models at the precalculus level and provides students with the skills and knowledge needed for calculus. The models developed in the course are primarily based on discrete mathematical topics such as difference equations, data analysis, probability, and matrix algebra. The course involves computer and/or graphing calculator work to investigate most of the mathematical models. It also involves a variety of live classroom experiments to investigate how well the mathematical models reflect actual processes or to help develop mathematical models based on observed experimental data. The course features a series of student investigations to provide a real-life dimension. It is designed to provide students with the motivation and impetus to continue on in mathematically related fields by exposing them to the wide applicability of mathematics.

Mathematics Improvement Project for Underrepresented Students

Betty S. Travis	DUE-9254165
University of Texas San Antonio	FY1993 $ 79,946
San Antonio, TX 78285	Mathematics

The Mathematics Improvement Project (MIP) represents a concentrated effort to increase the numbers of underrepresented students majoring in science, mathematics, or engineering at the University of Texas at San Antonio (UTSA) by focusing on their successful completion of college algebra and precalculus. The project is incorporating programmatic structures that facilitate faculty training, curricular design and implementation of pedagogical practices designed both to meet the special needs of underrepresented students and to promote critical thinking and mastery of mathematical concepts. Four faculty within the Division of Mathematics, Computer Science and Statistics (MCSS) at UTSA are working as MIP faculty, designing and implementing a culture-sensitive learning environment as well as a non-traditional instructional curriculum to insure that students are prepared to work in the global community of the 21st century. Although the program is open to all students, underrepresented students enrolling in college algebra and precalculus are being targeted. Through collaboration with the university's Student Services offices and by formalizing ties with local schools and community colleges, this program is implementing an effective system of recruitment, retention, and successful completion of the MIP mathematics sequence for underrepresented students. MIP's pipeline is generating a new momentum which allows students to build confidence and to achieve an incremental gain in skills powerful enough to ensure success in future mathematics courses. The overall goal is to increase the rate of undergraduate students successfully completing the math sequence by at least 20%.

Math Horizons

Donald J. Albers	DUE-9255393
Math Association of America	FY1993 $ 50,000
Washington, DC 20036	Mathematics

The Mathematical Association of America (MAA) is developing a new publication called MATH HORIZONS (MH), a quarterly magazine for students enrolled in undergraduate mathematics courses and advanced high school students. Students are significantly involved in the publication, which has articles on a variety of mathematics topics. It also includes problem sections and provides career information.

Mathematical Sciences: Geometry of Configurations, Polygons and Polyhedra

Branko Grunbaum	DMS-9300657
University of Washington	FY 1993 $ 90,000
Seattle, WA 98195	Mathematics

The research involves investigations in the fundamental geometry of convex polytopes, configurations and combinatorial aspects of symmetries. Applications are proposed to tiling patterns in a variety of contexts including architectural design and stereoscopic viewing. Another component of the proposal entails an undergraduate education activity in aspects of geometrical structure. The investigator is further developing instructional material in several areas of geometry suitable for students at the high school and junior college level. Activities for participation of teachers at these levels is being carried out.

Technology-Based Learning: Exploring Statistical Concepts and Methods

William I. Notz, Dennis K. Pearl	DUE-9346880
Elizabeth A. Stasny	FY 1992 $ 108,592
Ohio State University	FY 1993 $ 167,000
Columbus, OH 43210	FY1994 $ 128,816

New data-analytic and concepts-based textbooks along with advances in statistical software, computer technology and multimedia technology now offer the opportunity to rethink the way in which statistics is taught. Specifically, the following are now available: (1) well-written texts that emphasize data analysis and statistical concepts, (2) accessible statistics software that encourages data exploration and is easy for students to learn, (3) videotape material that gives broad coverage to statistical concepts and applications and (4) multimedia technology that is affordable.

The goal of this project is to combine and augment these resources to develop a unified curriculum and supporting materials for teaching introductory statistics. The following are being created: (1) laboratory manuals designed as a bridge between standard texts and computer software that guide students through experiments and generate data for analysis, (2) "start-up" materials to help students, especially disadvantaged students, get started using computers for statistics, (3) a machine-readable encyclopedia of examples and problems that includes data, descriptions of experiments, edited "bites" from existing video materials keyed to specific statistical concepts and tied to an instructional statistics program, and computer-based retrieval and (4) a Data Analysis Resource Room for dissemination of laboratory manuals, materials useful for conducting physical experiments in lecture demonstrations, and software including the encyclopedia of examples.

When this project is complete, it will represent the first time that such a comprehensive package of multimedia materials is used in introductory statistics courses. The time frame for the grant anticipates the wide availability of inexpensive technology and allow for materials to be pretested on a broad student audience, then ready for immediate dissemination. Materials developed will also be evaluated by an Advisory Board comprised of faculty from Ohio State and high school teachers from the Columbus area.

The immediate impact of such courses on the quality of undergraduate education at the Ohio State University is significant since there are approximately 30,000 undergraduate students who are required to take statistics. At Cornell University the materials developed under this grant are being used in their largest undergraduate introductory statistics sequence. Dissemination of materials developed under this grant is improving undergraduate teaching of statistics, making effective and integrated use of new materials and technology being developed, increasing enthusiasm for statistics among students, and making statistics more enjoyable to teach nationwide.

Invited Foundational Papers on Research in Undergraduate Mathematics

Ronald C. Rosier, James J. Kaput	RED-9353210
Conference Board of the Mathematical Sciences	FY1993 $ 15,500
1529 18th St. NW	Mathematics
Washington, DC 20036-1385	

Researchers in mathematics education are writing foundational papers to be included in the new Conference Board of the Mathematical Sciences series research in collegiate mathematics education. These papers serve both pure and applied purposes, contributing to the field of research in undergraduate mathematics education and informing the direct improvement of undergraduate mathematics instruction. These dual purposes imply dual but overlapping audiences. Papers focus on learning within particular mathematical domains as well as on more general cognitive process such as problem solving, skill acquisition, conceptual development, mathematical creativity, and cognitive styles. Papers also deal with issues associated with variations in teaching methods, or classroom and laboratory contexts. More broadly, research addresses institutional arrangements intended to support learning and teaching; for example, curriculum design, assessment practices, or strategies for faculty development.

Computer Experiments in Differential Equations

Robert Borrelli, Courtney S. Coleman	UFE-9347717
Harvey Mudd College	FY1993 $72,678
Claremont, CA 91711	Mathematics

A consortia of six institutions is conducting a series of six week long workshops over a three year period to enhance the expertise of mathematics faculty in the development and use of interactive computer experiments in differential equations. Consortia members are Cornell University, Harvey Mudd College, Rennselaer Polytechnic Institute, St. Olaf College, Washington State University and West Valley College. The computer projects are designed to be hardware/software independent and are intended to supplement standard courses in order to add another dimension to instruction in ordinary differential equations. The primary goal of each workshop is to develop faculty expertise on a particular hardware/software platform so that they can design and use interactive computer experiments in a laboratory environment. A second goal is to develop an ongoing Consortium to promote the writing and evaluation of computer experiments in differential equations and its applications as well as in related areas of mathematics.

Technology-Based Learning: Exploring Statistical Concepts and Methods

Paul F. Velleman
Cornell University
Ithaca, NY 14853

DUE-9346881
FY1992 $ 52,843
FY1993 $ 76,716
FY1994 $ 65,896
Mathematics

New data-analytic and concepts-based textbooks along with advances in statistical software, and computer and multimedia technology now offer the opportunity to rethink the way in which we teach statistics. This project, in coordination with an effort at Ohio State University (9156258), is combining and augmenting these resources to develop a unified curriculum and supporting materials for teaching statistical concepts and methods. Products of the project include: laboratory manuals designed as a bridge between standard texts and computer software that will guide students through experiments that generate data for analysis, start-up materials to aid students use computers for statistics, a machine-readable encyclopedia of examples and problems that will include data, descriptions of experiments and computer-based retrieval, and a computer CD-ROM archive of edited video materials keyed to specific statistical concepts and tied to an instructional statistics program.

New Technologies for the Blind: Improving Accessibility to Science

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HRD-9348406
FY1993 $102,794
Mathematics

At present, blind people have limited access to scientific literature and few means beyond "working it out in one's head" to do math. New raised-print technology permits printing scientific equations, figures and diagrams that can be read tactilely. Development and testing of an equation-printing method that retains the intuitive and conceptual advantages of the standard spatial representation of math equations is under development. Research to date has worked with equations comprised of braille numbers and letters and with tactile representations of the math symbols that replace the often ambiguous braille math symbols. Math equations are now presented in a spatial format as they are for sighted people, unlike that used with braille. Fractions are printed as numerator over denominator. Subscripts and superscripts are printed in the proper sub or superscripted positions. Limits of sums and integrals are printed in their normal positions. The symbols are represented by compact tactile patterns that can be read more easily than the Braille math symbols. The process is referred to as the "Dots" method.

Research is being done to determine whether representation of common math symbols can be done with an enhanced 6-symbol cell with three distinguishable symbols, or if it will be necessary to use an 8-symbol cell with two symbols. Work is also being done to use the enhanced Braille cell to represent alphabetic charters, greek, italic, bold, script, etc. Non-overprinted attributes (for example, vector signs, dots, carets, tildes, and other such things over a character) are being printed normally with some enhancement for readability.

The printing technology needed for producing such dot equations exists, but an actual machine does not. The project has been promised a beta-test version of a desk-top plotter capable of making any of the required shapes.

During the project, the Director is working with two undergraduate computer science students, one of whom is blind. In addition, he is researching international activities in aspects of blind technology. The research being done should result in the ability to write equations for blind people that retain all the intuitive and conceptual advantages of visual equations.

Mathematical Sciences: Modern Interdisciplinary University Statistics

G.E. Dwoskin
National Academy of Sciences
Washington, DC 20418

DMS-9221287
FY1993 $95,000
Mathematics

The Board on Mathematical Sciences (BMS), National Research Council (NRC) through its Committee on Applied and Theoretical Statistics (CATS) is convening two 1-1/2 day symposia on the topic Modern Interdisciplinary University Statistics Education, one at the National Academy of Sciences in Washington, DC, and one at the Beckman Center in Irvine, CA. The topics of discussion at these symposia are changes in statistics education are needed to: (1) incorporate interdisciplinary training into upper-undergraduate, graduate, and postdoctoral statistics programs, (2) bring upper-undergraduate and graduate statistics curricula up to date, and (3) improve apprenticing of statistics graduate and postdoctoral students and appropriately reward faculty mentors. Proceedings based upon the presentations and discussions at both symposia are being produced and disseminated after the second symposium.

PHYSICS

Development of a Discovery Approach for Introductory Level Physics Courses

S. Leslie Blatt, Christopher P. Landee, Harvey A. Gould	DUE-9254222
Clark University	FY1993 $ 240,000
Worcester, MA 01610	Physics

For the past three years, we have been developing and offering an innovative course, "Discovering Physics," for non-science majors. We are now broadening the approach we have been taking, which includes elements of the "discovery technique" and the small-group "complex instruction" learning environment, to both the elementary/middle school level and the standard college science-major physics sequence. The original course is being expanded to two semesters, and is being aimed especially at students planning to go into precollege teaching. Active participation of current teachers is also being emphasized, as an important part of the developing partnership between the University and the Worcester Public Schools. The course will retain its stress on understanding nature through direct experience and the concepts which grow out of careful consideration of these experiences. We are continuing to encourage students to ask "How do we know...?" and "Why do we believe...?" questions about physical phenomena. Our program welcomes, and has been successful with, both male and female students and students from groups traditionally underrepresented in science. To promote a broad, national impact, we are producing a "discovery workbook," a teacher's manual, and associated software. An outstanding group of consultants is working with us in the various aspects of this project.

Peer Instruction: Stimulating Renewed Interest in Physics and Other Science and Engineering Courses

Eric Mazur	DUE-9254027
Harvard University	FY1993 $ 100,000
Cambridge, MA 02138	FY1994 $ 100,000
	Physics

The problem addressed by this project is the widespread student dissatisfaction with traditional introductory science courses. Our work indicates that the primary cause of this problem is that too much emphasis is placed on problem-solving skills, while too little time is spent explaining and discussing fundamental concepts. As a result, students often memorize problem-solving strategies without understanding the concepts which underlie their manipulations. The passive lecture format generally employed in the introductory classes further exacerbates the problem. Our plan for addressing these difficulties is to adopt a simple and effective instructional technique -- ConcepTests coupled with Peer Instruction -- which helps to revitalize instruction and to improve student understanding. The two principle objectives of the technique are: 1) to expose students' common misconceptions about fundamental principles via ConcepTests, and 2) to rectify these notions and promote greater understanding of fundamental principles through peer instruction.

We have begun to implement this method in our introductory calculus-based physics course and have already collected massive amounts of data on the students' attendance, improvement and on the effectiveness of the technique. Preliminary evaluation of these data has shown that the new lecture format and its emphasis on conceptual understanding and student interaction have led to improved student performance both on conceptual questions and on traditional numerical problems. This initial investigation is continuing; our methods and conceptual questions are being adapted and refined based on our preliminary experiences. We are also extending this work to include further detailed data analysis, as well as the compilation of a collection of ConcepTests covering the entire introductory physics sequence. We have started to disseminate the initial results of our research in invited talks at various conferences and detailed statistical analysis is being carried out and prepared for publication. Although we are only just beginning to systematically catalogue our results, instructors at a variety of institutions have already adopted our method with very positive results. In addition, the method has been implemented in the introductory physics course for engineering majors at the University of Massachusetts at Lowell by our collaborator, Prof. Albert Altman. Here too, the results of the experiment are overwhelmingly positive. The success of the method in these various institutional settings indicates that the utility of the technique is not limited to any special audiences and does not depend on student background or prior experience. We hope that the ultimate impacts of improved student understanding are greater appreciation of the material and increased interest among students in the sciences.

PROJECT SOCRATES: Improving Physics Education Through Interactive Engagement

Richard R. Hake	DUE-9253965
Indiana University Bloomington	FY1993 $ 104,149
Bloomington, IN 47405	FY1994 $ 123,665
	FY1995 $ 119,692
	Physics

The Indiana University SOCRATES PROJECT is contributing to a critically needed national improvement in university introductory physics education through research on and development of interactive engagement methods for cost-effective mastery learning. In particular, this project is further developing, improving and promulgating the Socratic Dialogue Inducing (SDI) Lab method which has been shown to be effective in promoting student crossover to the Newtonian world. The focus is on mechanics and related areas (fluid statics and dynamics, oscillations and waves). The testing ground is the Indiana University Physics Department's General Physics I, a large-enrollment, non-calculus course for science (but not physics) majors (including prospective high- and middle-school teachers). "Real-world" in-class investigation, well-controlled out-of-class research with paid student subjects and in-depth case studies are being utilized. The goals sought are to: (1) improve and systematize the Socratic-dialogue and SDI lab techniques, (2) collaborate with other instructors to modify the SDI method for various instructional settings, (3) improve and extend the laboratory modules and instructor's guides, (4) more widely disseminate the method by means of publications, talks, workshops and distribution of videotapes and lab modules and (5) continue the construction of computer Force-Motion-Vector Animations to assist laboratory and lecture instruction.

Establishment of Extended General Physics - An Alternative Course for Underprepared Students

George K. Horton, Brian Holton	DUE 9254247
Rutgers University Busch Campus	FY1993 $ 263,940
Piscataway, NJ 08854-1089	Physics

Rutgers is the state university of New Jersey located in a urban area with 33,000 students on its New Brunswick campus. Most undergraduates at Rutgers are first generation college students and 30 percent are minorities. Many are underprepared to succeed in the sciences. Our proposed project is to create a physics course specifically for underprepared science and pre-health profession majors that is rigorous, laboratory based, and non-threatening. Based on our experience with a somewhat similar course for engineering students and the research findings and developments of others, we are designing a program with active lectures, cooperative learning and qualitative and quantitative laboratories that will help our students succeed in science and pre-health profession majors and be exportable to other colleges and universities schools.

Cost Effective Laboratory for a Large General Education Physics Class

Alexander F. Burr	DUE 9254369
New Mexico State University	FY1993 $ 150,610
Las Cruces, NM 88003	Physics

A new type of laboratory experience is being developed for a general education physics course primarily based on experiments carried out by students in their own residences utilizing a kit of inexpensive components and directed by a carefully crafted laboratory handbook supplemented by a few video tapes. The tangible results of the project will be a tested and evaluated laboratory course based on this kit of equipment, the professional laboratory manual available in printed and computer readable form, and the videos. These materials will be made available for adoption by other schools. The program will be easily transferable, easily modified and self-financing in that a net savings of many dollars will immediately result when this laboratory form replaces the conventional form.

A Combined Calculus-Based/Non-Calculus Introductory Physics Course Using the Workshop Physics System

William R. Warren	DUE-9254094
Lord Fairfax Community College	FY1993 $ 30,649
Middletown, VA 22645	Physics

The Workshop Physics system, in which traditional lectures and laboratories are replaced by interactive learning methods and microcomputer-based laboratory activities, will be used to provide a combined calculus-based/non-calculus introductory physics course. Additional interactive methods such as conceptual exercises, collaborative problem-solving and multimedia technology will be incorporated into the existing Workshop Physics curriculum. This will result in improved student learning and more efficient use of instructor time.

Introductory University Physics Project (IUPP)--Phase III

John S. Rigden	DUE 9245297
American Institute of Physics	FY 1991 $ 500,242
New York, NY 10017	FY 1992 $ 499,533
	FY 1993 $ 50,252
	Physics

The Introductory University Physics Project (IUPP) is designed to develop and promote new models for the calculus-level introductory physics course. Key goals are a reduction in the number of topics covered and the integration of contemporary physics into the course content, all of which is organized around a coherent "story line." Phase III of IUPP is directed toward model development and classroom testing. Five models will be tested in classrooms of 2-year colleges 4-year colleges, and universities that have expressed an interest to be test centers. As these models are tested, each will be evaluated by a group specifically organized for this purpose. When the formal activities of the project come to an end, the IUPP Steering Committee will report on its results and will encourage the use of the finished models in other institutions until commercial textbooks become available.

Physics for the Year 2000

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San Luis Obispo, CA 93407

DUE-9155497
FY1993 $55,000
Physics

The calculus-based introductory physics course, with an annual national enrollment of roughly 150,000 students, is the educational cornerstone for all physical science and engineering majors as well as the primary influence on general physics courses at lower levels. This project draws upon: (1) physics education research, (2) computer technology and software development for physics, and (3) guidelines developed by the Introductory University Physics Project in order to create a unified new curriculum for the course. Emphasis is placed on incorporating effective pedagogy into the course, on the use of a "story line" and improved course structure, and on bringing a significant component of 20th-century physics into the course. The primary aspect of this project that sets it apart from curriculum development efforts elsewhere is that it will be aimed primarily at large universities teaching large numbers of students. This is the target audience that must be reached if new developments in science education are to succeed. Specific attention is being given to the many constraints that a large university setting places on the course. Outside experts in physics education will assist with the assessment of this project. Dissemination of results will initially be to universities interested in trying the material. The ultimate product will be a textbook with supporting software and a teachers guide.

Active Construction and Application of Conceptual Models--A Physics Learning System

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DUE-9156058
FY 1992 $ 150,000
FY 1993 $ 140,000
FY 1994 $ 150,000
Physics

During the past two decades, physics education researchers and cognitive scientists have identified serious deficiencies in conventional physics education. Students' initial conceptions (mostly misconceptions) about the physical world remain unaltered. Students use primitive formula-centered problem-solving strategies that have little use in practical situations. Students' knowledge after completing their study consists of random facts and equations ineffectively organized for retention or accessibility. In recent years, experiments in new forms of physics instruction have shown that we can do much better. In these educational experiments, students are active participants in constructing physics concepts and in using the concepts to solve problems.

In this project, two new sets of active learning materials are being developed with the goal of helping students more effectively: (1) construct qualitative understanding of fundamental physics concepts, (2) analyze complex problems quantitatively in an expert manner and (3) form a knowledge structure that can be easily accessed when needed. The new materials that are being developed include a set of *Concept Construction Experiments* and a set of *Experiment Problems.* The Concept Construction Experiments are groups of experiments that are performed for students in lectures or by students in laboratories. Following the experiments, students working in small groups construct conceptual Models that are consistent with their observations. Often these activities are qualitative in nature. The Experiment Problems involve simple sets of apparatus that are used to perform an experiment stated as a problem. Students use expert like strategies to plan and execute a solution to the problem. They learn to define poorly defined problems; to divide complex problems into parts; to access the appropriate knowledge for each part of the problem; to decide what unknown information is needed to solve the problem; to make rough estimates in order to supply missing information; and to justify assumptions made in their analysis. The problem is then solved and the results are evaluated by performing the experiment.

The program will be evaluated by comparing student achievement on qualitative and quantitative tests prepared by an external evaluator. Additionally, the effect of these activities performed in a laboratory setting on student achievement in traditional lecture sections will be also be recorded. Dissemination will occur by presentations at regional and national meetings, papers in journals, and by distributing laboratory manuals initially through a copy center and later through publishers. Previous use of active learning materials in a lecture setting has produced significant gains in student completion rates and in their scores on qualitative and quantitative tests. The use of a coherent lecture-recitation-laboratory learning system that is built on research and relies on active student participation should have a positive effect on the more than 300,000 science and engineering students who take the introductory course in physics each year.

Electrical Interactions and the Structure of Matter: Qualitative Reasoning in an Electricity and Magnetism Course

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Pittsburgh, PA 15213

DUE-9156105
FY 1992 $ 68,126
FY 1993 $ 71,990
FY 1994 $ 75,592
Physics

Existing introductory physics courses on electricity and magnetism are often overly formal and mathematical, with a large number of difficult abstract concepts such as field, potential, and Gauss's Law. The analysis of electrical circuits is completely divorced from the analysis of static electricity, making these two aspects of electrical phenomena seem like two distinct sciences. The typical course overemphasizes disembodied fields and says very little about real matter.

A fundamentally new course on electricity and magnetism is under development. The goal of the course is to have students engage in a process central to science: the attempt to explain in detail a broad range of phenomena using a small set of powerful fundamental principles. We teach students a unified approach to reasoning qualitatively about a wide variety of electrical and magnetic interactions, which they then use in the process of solving both qualitative and quantitative problems. The qualitative work on both electrostatics and circuits is based on the physics of the basic Coulomb interaction and of the atomic structure of matter, initially without the use of the secondary concepts of electric potential and Kirchhoff's rules. There is a major emphasis on teaching students how to construct rigorous, qualitative explanations of physical phenomena, including how to construct and use good diagrams as tools for both reasoning and explaining. A central element of the course is a workbook which guides students in designing and carrying out desktop experiments, and in writing explanations in terms of qualitative and quantitative analyses. Several computer programs are used to help students visualize difficult or abstract concepts.

Experimental work is central to the course, but does not require special laboratory sessions: students work in class or at home on desktop experiments in electrostatics and on resistive and capacitive circuits, and on the unified atomic-level analysis of these experiments. The fundamental physical understanding that results from the qualitative and experimental work is the foundation for the more traditional and more quantitative material that is also a part of the course, including electric field, potential, Kirchhoff's rules, Gauss's Law, the Lorentz force, the Biot-Savart Law, Ampere's Law, and Faraday's Law. Relativistic effects receive some attention, including retardation effects in establishing the steady state in a circuit.

Ongoing evaluation of the course has stimulated major revision of the student workbook, especially in the way in which circuits are analyzed in terms of the fundamental Coulomb interaction, and in the addition of worked-out solutions to give students models of what a good written explanation looks like.

We have sent draft versions of the workbook and auxiliary course materials to many interested physics teachers, and we have submitted two of our award-winning computer programs for publication by Physics Academic Software. We know of two college teachers and two high school teachers who are already using our draft materials in their courses. Work is under way at Amherst College to adapt our materials to a shorter presentation within one of the experimental courses of the national Introductory University Physics Project. At the Weizmann Institute, which has responsibility for all science education in public schools in Israel, our materials are being adapted for use in high school physics courses.

Physics and the 3 R's: Recruit, Restructure, and Retain

Gerald W. Meisner, Richard L. Pontig
University of North Carolina - Greensboro
Greensboro, NC 27412

DUE-9156179
FY 1992 $ 172,141
FY 1993 $ 127,626
Physics

The Physics Department of UNC Greensboro and the Department of Mathematics and Computer Science of Bennett College in Greensboro, North Carolina will test and integrate a two-semester introductory physics course for science majors into the curriculum which will serve either as preparation for or as a replacement of the traditional survey course. This project is a cooperative venture between a predominantly white state university of 11,000 and a private college of 600 African-American women. The purpose of this project is to evaluate the effects of a decidedly different approach to the traditional two-semester introductory physics course on women, minority, and "second tier" students. We will measure their attraction to the course, the knowledge of physics gained and retained during the course, the retention rate of the students in the course, as well as their future success in courses in the physical sciences and mathematics. The tenet behind the course comes from recent research in physics education, observations collected by the PI's over many years of teaching introductory courses, recent work done by the PI in Project PIEDMONT, documented evidence describing the low entry rate and high attrition rate of women and non-Asian minorities in physical sciences, and the demographic studies which profile the necessity of increasing the numbers of these populations in the areas of science, mathematics, and engineering. Students in the course will examine fewer subject areas in greater depth than students in the usual survey course, and will do so in ways which are pedagogically sounder and intellectually more exciting. The four credit-hour per semester course will take place entirely in a laboratory setting for two hours per day, three days a week, will develop a firm foundation of concrete experiences through a method of guided inquiry, and will expose students to the use of modem data acquisition and analysis tools through a microcomputer-based laboratory component.

Established minorities and women in the physics community will help us in recruiting students from our pool of high school and undergraduate applicants. The offices of Women's Studies and African-American Studies will assist in the retention phase. We are establishing a list server for those faculty involved with similar efforts across and outside the country.

Student-Oriented Science (SOS): Curricula, Techniques, and Computer Tools for Interactive Learning

Ronald K. Thornton	DUE-9254340
Tufts University	FY1993 $ 230,000
Medford, MA 02155	Physics

The physics education establishment is reconsidering the goals and approaches to the teaching of introductory physics. There is general agreement that new insights based on research in physics education and cognitive science should be taken into account in the development of new models for teaching introductory physics. Dramatic gains in the conceptual learning have occurred in introductory physics courses when students are exposed to active learning using microcomputers and guided inquiry in the laboratory and classroom. Similar interest in more effective teaching methods is also growing in chemistry and biology. The SOS project is working to improve introductory science courses by supporting three synergistic strands of development.

(1) The project is continuing to develop the award winning real-time data logging and analysis software and associated hardware (commonly called MBL or Microcomputer-Based Laboratory tools) for Macintosh and MS-DOS platforms. Existing tools are being modified and new tools produced that are of use to the wide range of students in introductory science courses. In addition to producing tools that serve the physics community, the project is working with chemists and biologists to produce general tools that serve the pedagogical needs of their courses. We are improving the software, probes, and the Universal Laboratory Interface, and we continue to distribute curricula and software at nominal cost through Vernier Software.

(2) Our broadly based curricular development effort is contributing to the improvement of introductory physics courses at a wide range of institutions. We are developing and supporting interactive introductory physics materials of the type developed in the *Tools for Scientific Thinking Project* at Tufts University and in the *Workshop Physics* program at Dickinson College. The flexibility of these materials and the MBL tools allows colleges and universities to incrementally introduce changes and experiment with new models of teaching. We are paying special attention to the learning environment found at large universities (and community colleges) and continue to evolve methods for introducing effective interactive learning methods into large physics classes. Our current work with the University of Oregon, Ohio State, University of Texas - Austin, and Arizona State will give us a good start. We are developing a new laboratory curriculum called *RealTime Physics and Interactive Lecture Demonstrations* for large classrooms. Because many colleges, community colleges, and universities are using or wish to use and adapt our tools and curricular materials, we are able to test both individual learning modules and total curricula. Several criteria are used in the evaluation of the materials including student attitude toward science, level of scientific literacy, and conceptual learning gains. We are producing materials that work well with underprepared, minority, and science-anxious students and with non-science as well as science majors.

(3) Benchmark evaluations are being developed from research in conceptual learning done at the Center for Science and Math Teaching at Tufts. These conceptual evaluations continue to convince institutions that traditional methods of physics teaching are not working well and to provide evaluation of new curricular change. The educational research also guides the SOS project in the development of software tools and curricular materials.

CUPLE: The Comprehensive Unified Physics Learning Environment

Jack M. Wilson	DUE-9156228
Rensselaer Polytechnic Institute	FY1992 $ 159,932
Troy, NY 121803590	FY1993 $ 160,451
	Physics

The CUPLE Consortium has produced a prototype of a new instructional resource for college and university physics courses. CUPLE is comprehensive because it draws on innovative developments in classroom, laboratory, lecture demonstration, computational physics, videodisks, and computer-based materials that have been developed by outstanding physics educators from all over the country. It is unified because it combines these materials in a delivery system that is based on a hypertext multimedia environment that presents a consistent user interface to the students and faculty, eliminating the need for the user to learn the idiosyncrasies of many different systems.

The prototype system includes all of the tools necessary for the complete system, including data acquisition for microcomputer based laboratories (MBL), student problem-solving through program construction (M.U.P.P.E.T. and WinPhys), integration of video into computer displays (including the ability to make measurements on screen), spreadsheet physics materials, and a hypermedia authoring system that pulls all of these tools together in an environment that allows faculty (or students) to develop new materials using these tools without the need to resort to sophisticated programming.

This project is extending that system to additional content areas, enlarging class testing of the system at cooperating universities, using the results of class testing and the ongoing technical beta testing to further refine the materials and tools and to develop the browser and class design tools necessary to allow faculty to design custom courses if they wish. Present plans call for the materials to be distributed through a cooperative arrangement between the American Association of Physics Teachers and the AIP/AAPT-sponsored Physics Academic Software program.

Conference on the Introductory Physics Learning Environment

Jack M. Wilson	DUE-9350168
Rensselaer Polytechnical Institute	FY1993 $ 28,838
Troy, NY 12180-3590	Physics

A conference was held at Rensselaer to bring together and discuss a variety of projects to revise and reform the introductory physics course. Attending were principals from most of the major projects and a large number of interested participants.

Innovative Introductory Physics Laboratory Course

Vincent Santarelli, Daniel E. Murnick	DUE-9155823
Rutgers University Newark	FY1992 $ 158,117
Newark, NJ 07102	FY1993 $ 157,594
	Physics

An Introductory Physics Laboratory Course at Rutgers-Newark is being developed using microcomputer-based instrumentation to improve the understanding and appreciation of the laws of physics and of the instrumentation and methods of modern physics and technology. The makeup of the Rutgers-Newark student body and the geography and demographics of the Newark area, coupled with significant outreach efforts, ensures a large minority student participation in this project. Teaching and teaming strategies geared to the needs of this diverse urban student population are being developed. These strategies utilize non-intimidating but rigorous discovery-based experiments and provide a meaningful and accurate introduction to the excitement and creativity of scientific discovery and analysis. The course uses modern sensors for motion, force, temperature, sound and electromagnetic field measurements. The sensors are being interfaced to Macintosh microcomputers allowing the students to analyze their measurements rapidly and to explore alternative physical hypotheses. The project attracts more students into physics and engineering, producing better educated students with critical analytical skills in all majors. The program is being adapted for and shared with high-school teachers and their students as well as two-year college faculty and students.

Conceptual Astronomy: A Process Oriented Course

Michael Zeilik	DUE-9253983
University of New Mexico	FY1993 $ 65,831
Albuquerque, NM 87131	FY1994 $ 61,313
	Astronomy

The project aims to deliver an innovative introductory astronomy course for non-science majors at a non-selective state university. The main thrust of the project is to design a course that focuses on the process of science by identifying and linking essential astronomical concepts with a minimum of supporting information. Within a large lecture course, new delivery technologies are being tested to increase interaction and communications so that students will play an active role to engage them with the new material. The integrated, tested package should be readily transported to other state university environments.

Astronomy and Writing: An Innovative Approach to Science Instruction

Bernard J. McNamara	DUE-9253979
New Mexico St. University	FY1993 $ 34,000
Las Cruces, NM 88003	FY1994 $ 94,515
	FY1995 $ 47,884
	Astronomy

The goal of this project is to help incoming students develop critical thinking skills and a better understanding of basic scientific principles. The goal of the project is to construct an astronomy workbook that utilizes both math and writing. At New Mexico State University a large portion of the student body is Hispanic, so particular care is being given to constructing exercises appropriate to this group. The workbook will utilize the techniques of "Writing-Across-the-Curriculum" (WAC). Numerous investigations have found that a strong relation exists between writing and learning. Writing has also been shown to be an effective tool in physics and math instruction. The project is designed to exploit the values of writing as a learning tool in astronomy. The incorporation of WAC techniques into a beginning astronomy class, at this level, is a unique experiment. The intent is that the project serve as a prototype for future efforts in the physical sciences at New Mexico State University and that the material developed here be transportable to other institutions.

Modernizing the Introductory Astronomy Laboratory

Laurence A. Marschall	DUE-9155927
Gettysburg College	FY 1992 $ 107,680
Gettysburg, PA 17325	FY 1993 $ 130,880
	Astronomy

Astronomy is a very popular course for undergraduates, particularly non-science majors fulfilling their science requirements. For many, it is their first and only experience with a college-level science course, and the laboratories associated with it afford a unique opportunity for students to get a first-hand acquaintance with the objects and methods of science. Yet laboratory exercises in introductory astronomy classes have long suffered from the difficulty of doing experiments with the faint light from the heavens. They are rarely experiential or "hands-on," relying instead on analysis of photographs and data tables provided ahead of time. The available laboratory material today also exemplifies techniques that are increasingly out-of-date and unrepresentative of what astronomers really do. Students, in our experience, rightly regard much of the lab as make-work, rarely reinforcing the concepts presented in class.

Modern astronomy makes much use of digital imagery and computer technology; such techniques could greatly enhance the quality and the appeal of introductory astronomy labs. We are developing a series of new exercises for the introductory classroom which make extensive use of computers and digital data. About a dozen exercises will be developed during the period of the grant. Some are simulations of observations, which can be extremely realistic because computers are in fact used as the control units for most real astronomical instruments. Other exercises utilize observations made with CCD cameras on small telescopes, of the kind available to many schools. Standardized software tools are being developed for all the labs with the help of a programming staff.

The finished exercises will consist of software, write-ups, and teachers' guides, as well as technical manuals. They are being made available to other institutions as packages of disks and printed material, as well as by computer access through the Internet. A summer workshop, with faculty from other colleges participating, will meet during the second summer of the grant on evaluating what has been done to date, developing new ideas, testing exercises on their classes, and disseminating material to others. We are also presenting the results in papers at meetings and professional journals.

We have a growing mailing list of interested faculty at other colleges, and a number of colleagues at other institutions who have contributed ideas and who are in contact with us to share our concerns. The project will give students in our classes a more satisfying and realistic experience in astronomy, and will provide impetus for revitalizing the introductory astronomy offering at other colleges and universities.

Introductory Anthropology for Historically Black Colleges

Mary Ann Medlin	DUE 9254191
Barber-Scotia College	FY1993 $ 195,658
Concord, NC 28025	Social Sciences

This institution is developing an introductory-level undergraduate curriculum in anthropology for Historically Black Colleges and Universities (HBCUs). The curriculum begins with a two semester sequence in cultural anthropology and research methodology followed by a summer ethnographic field school. The second year includes a sequence of one semester of language and culture, a second semester of field research and a summer internship. A major focus of this project is the development of multimedia and interactive modules which will enhance students' understanding of basic anthropology, the research process and cultural and social perspectives. The proposed curriculum is also expected to increase the scientific and technical literacy of underrepresented minorities at other institutions.

Enhancing Undergraduate Learning in Natural Science: A new Curriculum for Laboratory Classes in Biological Anthropology

Herbert H. Covert, Darna L. Dufour	DUE-9254227
University of Colorado Boulder	FY1993 $160,468
Boulder, CO 80309	Social Science

We proposed to redesign the laboratory curriculum of a popular natural science sequence course to more actively engage students in the learning process by developing a set of problem oriented class exercises. In developing these exercises we will also be able to improve the integration of the laboratory experience with the lectures and standardize the material presented in different sections of the course. The course is Laboratory in Physical Anthropology I and II, which is a Core Curriculum course at the University of Colorado, Boulder, offered primarily for freshman and sophomore non-science majors. We plan to achieve our goals by working in partnership with undergraduates who have previously taken the course and can provide ongoing feedback on, and insight into, the student's role in the learning process.

Introductory Microeconomics: The Way We Live

Susan K. Feigenbaum, Anne E. Winkler,
Sharon G. Levin, Thomas R. Ireland
University of Missouri Saint Louis
Saint Louis, MO 63121

DUE-9254299
FY1993 $ 90,612
FY1995 $ 19,466
Economics

Economics teaches a way of thinking, "an ability to assess alternative choices in the face of constraints," that is fundamental to informed private and social choice. There is virtual consensus that an effective introductory economics course should teach students how to think intelligently and independently about economic issues. Yet, evidence suggests that we fall far short of this goal due to the increasingly encyclopedic and abstract nature of the material, and a failure to respond to the experiences of our increasingly diverse student population, especially women and minorities. Moreover, the social and economic impact of increasing global interdependence has likewise often been ignored.

We propose to develop an introductory microeconomics course that focuses specifically on the economic decisions that individuals make over the course of their lives. Introductory Microeconomics: "The Way We Live," will introduce economic concepts and analytical tools within the context of specific choices students face, such as the decision to get married or obtain a college education. Creating these connections between new information and previous experiences will provide a strong motivation for learning. In addition, the course will integrate exercises on numeracy and computer analysis, providing an active, hands-on learning environment. We believe that we can significantly enhance students' economic literacy, numeracy and appreciation for cultural diversity, by incorporating up-to-date data for such purposes as international comparisons,

Anthropology Curriculum for Human Prehistory

James W. Green, Angela R. Linse,
Julie K. Stein
University of Washington
Seattle, WA 98195

DUE-9254045
FY1993 $ 73,730
Social Sciences

This project provides a curriculum for introductory Anthropology, Archaeology and Prehistory Courses that emphasizes scientific procedures of analysis in five principal topical areas. These topical areas include; primate and hominid evolution, methods in prehistory, technological evolution and migration. Within each topical area, the program also focuses on a series of teaching and learning tasks such as modules and group laboratory and field activities. It is expected that the students will enhance their knowledge of evolution and prehistory, as well as acquire skills in the scientific process, data collection and evaluation.

Linguistic Semantics as Science

Richard.K. Larson, David S. Warren
SUNY - Stony Brook
Stony Brook, NY 11794-0001

DUE-9245282
FY1991 $ 222,397
FY1992 $ 115,728
FY1993 $ 32,667
Social Sciences

Linguistic Semantics as Science (LSAS) is a joint, three-year project by the departments of Linguistics and Computer Science at SUNY - Stony Brook. The project goal is to develop a new approach to teaching scientific reasoning and research methods using natural language as the object of investigation. The latter has certain natural attractions as an educational medium. Unlike many other phenomena of scientific interest, language is accessible in depth without the aid of calculus-level mathematics or complex technical apparatus, and without slow and arduous processes of data collection. The subject matter is also one to which all persons, and children in particular, show a natural affinity (as evidenced by the universality of language games of many kinds). Furthermore, because language is integrally connected with so many areas in the humanities and arts, its scientific study offers a natural means to reach students not otherwise considering science majors or extensive science electives. Linguistics offers an excellent route for introducing such students to the principles of scientific method and reasoning, enhancing the prospect that they will explore other areas in the science curriculum.

LSAS is attempting to develop curricula for natural language study in the specific subdomain of semantics, the study of meaning. This domain involves precise technical methods deriving from formal logic as well as broad conceptual issues deriving from philosophy. Because of this dual nature, work in semantics is very effective in developing mature scientific thinking, which must combine attention to detail with an ability to reflect on general issues. The specific task of LSAS is to create a sophomore-level undergraduate course introducing students, from a wide variety of backgrounds, to linguistic semantics. The heart of the course is a software application program, *Semantica*, that allows the student to explore semantic theorizing in an interactive, graphical environment. The course, software application and accompanying workbook will address various aspects of meaning, including its relation to word and sentence form (morphology and syntax), its relation to systems of mental representation (cognition), and the interaction between meaning and use (pragmatics). The goals of the course are to reveal to students the complex internal system of rules and principles that underlie our abilities as natural language speakers, to let students experience some of the intellectual excitement that comes with discovering such principles and struggling to formulate them in a precise way and to encourage students to explore the computer as a model of how we, as human beings, think and understand. We believe that the product of this work will be of significant value in introducing undergraduates to an exciting and rapidly developing subject matter and will help to foster interest and interdisciplinary exploration in the cognitive sciences.

LSAS is currently beginning its second year, with the project having made significant progress on both the underlying computational engine of *Semantica (constructed in* the language SBProlog) and its graphical user interface. Development is being carried out on the next computer platform, which offers a number of significant advantages in constructing graphical applications. We expect a prototype to be available for distribution by the end of summer 1993. The final project year will be devoted to further development of the application, the writing of the accompanying workbook and perhaps the transporting of the application to other platforms. Distribution of the materials is planned through MIT Press.

Although LSAS is currently confined to materials for a specific course, we anticipate extensions beyond linguistic semantics in future years. The parser and its interface for *Semantica* will form the basis for a *Syntactica,* which teaches similar skills from the point of view of grammatical data. Similarly, using the various resources available for sound processing in the next computer development kit, we foresee the possibility of a *Phonologica*--an experimental approach to phonetics and phonology. The concrete prospect is thus for a broad set of "Grammar as Science" materials developing from our current educational research effort. We strongly believe these materials will find application in many institutions beyond Stony Brook.

Development and Implementation of Introductory Laboratories in Psychology

Gary W. Hanson, Charles Wages,	DUE-9150832
Jesse J. Jordan	FY1991 $ 56,606
Francis Marion College	FY1993 $ 73,387
Florence, SC 29501	Psychology

A two-year project, developing and implementing two introductory lab courses in psychology as a vehicle for improving scientific and technological literacy and for attracting students to science careers. The project includes the development of twenty lab exercises which facilitate development of scientific thinking and demonstrate the process of science in the context of demonstrable psychological phenomena. In the second year, laboratories will be implemented and a laboratory manual produced.

PROJECT DESCRIPTIONS: CALCULUS AND THE BRIDGE TO CALCULUS

The Georgia Tech-Clemson Consortium for Undergraduate Mathematics in Science and Engineering

Alfred D. Andrew, Donald R. LaTorre
Georgia Tech Research Corp.
Atlanta, GA 30332

DUE-91553309
FY1991 $ 83,560
FY1992 $ 85,991
FY1993 $ 24,417
Calculus

A large scale adaptation, refinement and implementation project is invigorating teaching and learning calculus for science and engineering students. Innovations being adapted have been tested at each of the two participating institutions and at Iowa State University, New Mexico State University and Cornell University. The three year effort is taking advantage of both modern supercalculator and microcomputer technology, and incorporates group learning through team projects. The project will affect some 20,000 students over five years.

Implementing Computer-Integrated Calculus in High Schools

James F. Hurley
University of Connecticut
Storrs, CT 06269

DUE-9252463
FY1992 $ 177,746
FY1993 $ 197,064
FY1994 $ 219,434
Calculus

The project is adapting the University of Connecticut computer integrated calculus program to high school calculus courses under the University's High School Cooperative Calculus Program. University of Connecticut faculty and graduate students, and teachers from thirteen Connecticut high schools will work together to rewrite materials, present these materials at summer workshops and coordinate pilot testing of the materials. Revisions based on the pilot testing will be made, and full scale field testing implemented. Student performance in high school as well as subsequent performance at the University will be carefully tracked.

Calculus & Mathematica

J. Jerry Uhl
University of Illinois-Urbana
Urbana, IL 61801

DUE-9252484
FY1992 $ 150,000
FY1993 $ 150,000
FY1994 $ 150,000
Calculus

Calculus and Mathematica is a laboratory course in calculus based on electronic interactive notebooks written within the Mathematica system. In two years the teaching of Calculus and Mathematica has spread to more than twenty colleges and six high schools. The proposed work is continuing this project by extending the development, dissemination and evaluation of the existing Calculus & Mathematica project. Development includes a thorough revision of materials for Calculus I, Calculus II, and Calculus III, together with a pilot development of a Differential Equations course. Dissemination includes implementation in a network of rural high schools.

A Proposal for Implementing Calculus Reform in West Appalachia

James H. Well, Kenneth A. Kubota, Paul M. Eakin, Alice W. Brown
Kentucky Research Foundation
Lexington, KY 40506-0057

DUE-9252494
FY1992 $ 278,459
FY1993 $ 324,081
FY1994 $ 47,460
Calculus

Five private and five public colleges and universities located within or at the western boundary of appalachia and having an aggregate student body of over 60,000 are promoting the implementation of modern calculus curricula in their region by: (1) developing and achieving full implementation of calculus programs at their own institutions and (2) sharing the knowledge and experience gained through an extensive program of dissemination directed at both high schools and sister institutions. The availability, within the region, of a large, documented, widely disseminated sample of successful approaches and implementations is expected to motivate, encourage, and facilitate similar efforts at other regional colleges and universities. The latter, combined with programs to inform and involve high school teachers of calculus will contribute to the further extension of a revised calculus in the schools. In addition to workshops, consortium communication will be facilitated through an electronic network.

A New Calculus Program at the University of Michigan

Morton Brown, B.Taylor
University of Michigan-Ann Arbor
Ann Arbor, MI 48109

DUE-9252503
FY1992 $ 175,000
FY1993 $ 125,000
FY1994 $ 100,000
Calculus

program are: (1) an intensive and ongoing instructor training program for all faculty and teaching assistants; (2) a classroom environment that incorporates cooperative learning and experimentation by students; (3) major syllabus revision which emphasizes problem solving, geometric visualization, and quantitative reasoning; and (4) integration of the graphing calculator into the curriculum. The principal goals are: (1) a concept driven course; (2) students who are better prepared for, and more likely to take, further mathematics and science courses; (3) and are more enjoyable experience for students.

Mid-Atlantic Regional Calculus Consortium

Joshua A. Leslie, Louise A. Raphael
Howard University
Washington D.C. 20059 ·

DUE-9252508
FY1992 $ 25,000
FY1993 $ 50,000
Calculus

MARCC--a consortium of five Black universities, a two-year community college, and two inner city Black high schools--is implementing the Harvard Core Calculus Course over a one year period. MARCC, consisting of Benjamin Banneker High School, Cheney State University, University of the District of Columbia, Hampton University, Howard University, Lincoln University, Montgomery Community College, and Spingarn High School, enrolls over 2,000 minority students in their Calculus I and II courses. With this planning grant, workshops are being held for faculty in the represented institutions and implementation plans are being formulated for the consortium.

Implementation and Dissemination of the Harvard Consortium Materials in Arizona, Oklahoma and Utah

David Lovelock, D.O. Lomen
University of Arizona
Tuscon, AZ 85721

DUE-9252521
FY1992 $ 181,365
FY1993 $ 301,809
Calculus

The Harvard Calculus Consortium materials are being implemented throughout Arizona, Oklahoma, Utah, and the surrounding regions. Implementation will be achieved in two complementary steps. First, over three years, the coalition (Arizona State University, Brigham Young University, Northern Arizona University, Oklahoma State University, and the University of Arizona) will implement the reformed calculus. Second, the coalition activities will be expanded to include other two- and four-year institutions and high schools from the region. The three-year plan consists of six parts: (1) A series of half-day informational discourses to inform colleagues, members of the client disciplines, high school teachers, future participants from two- and four-year institutions. (2) A series of on-site workshops to train instructors: full-time faculty, part-time faculty, adjunct faculty, teaching assistants, and high school teachers. (3) A series of on-site workshops to train undergraduate graders and tutors. (4) A one-day site-visit with participants each month during the semester following the workshops. (5) The establishment of an electronic mail and bulletin board type facility for all users of the Harvard Consortium material. (6) A series of presentations at regional and national professional meetings intended to encourage attendance at either an informational discourse, or the workshops themselves.

Fully Renewed Calculus at Three Large Universities

John Unbehaun
University of Wisconsin-La Crosse
La Crosse, WI 54601
DUE-9253958
FY1992 $ 59,009
FY1993 $ 30,178
FY1994 $ 26,113
Calculus

Gurcharan S. Gill
Brigham Young University
Provo, UT 84602
DUE-9253959
FY1992 $ 18,235
FY1993 $ 32,225
FY1994 $ 33,540
Calculus

Keith D. Stroyan
University of Iowa
Iowa City, IA 52242
DUE-9252486
FY1992 $ 80,472
FY1993 $ 39,751
FY1994 $ 42,184
Calculus

This collaborative project is being implemented at the University of Iowa, University of Wisconsin-La Crosse, and Brigham Young University. Renewed calculus materials developed through the NSF supported project at the University of Iowa will be revised, tested, and refined at these three institutions. The project involves extensive training of faculty and teaching assistants to use these materials and approaches. In addition to ideas through large open ended projects on a variety of scientific and mathematical problems.

Large-scale Calculus Revision at Penn

Dennis M. DeTurck	DUE-9352824
University of Pennsylvania	FY1993 $ 100,000
Philadelphia, PA 19104	Calculus

A full-scale revision of the entire Calculus program is being undertaken making extensive use of student projects drawn from scientific and business disciplines. The three main thrusts of the revision are (1) substantial reconstruction of the first and second year Calculus syllabi, (2) emphasis upon collaborative learning techniques and (3) use of computation as a vehicle to encourage collaborative learning. The emphasis is on designing and implementing means of presenting new approaches to Calculus effectively on a large scale. To carry this out in the context of a large research university with 2000 students per semester taking Calculus, materials are being adapted from existing Calculus reform efforts. In addition, materials and support are being developed for faculty and students laerning to use computers to do mathematics and to incorporating problems from other disciplines.Some sections of the new courses are team-taught with Math Education faculty, assisted by secondary mathematics education students as a portion of their preparation for teaching.

Calculus, Linear Algebra, and ODE's in a Real and Complex World

Franklin Wattenberg	DUE-9352828
University of Masssachusetts-Amherst	FY1993 $ 79,871
Amherst, MA 01003	Calculus

Being continued is the development, dissemination and assessment of an integrated two-year sequence to replace five courses: Calculus I, II, and III, Linear Algebra and Ordinary Differential Equations. The motivating idea driving this project is that these subjects should be taught in the context of real and engaging problems. By studying these subjects in context, students are better able to understand them and to use them outside the mathematics classroom. Pedagogically, the most important feature of this sequence is the participation of students at a higher level than is typical of traditional courses. Emphasized are very substantial and realistic problems that require the application of a combination of mathematical techniques and that are open-ended, often without clean, simple solutions. Computers and writing are essential parts of the approach. Computers make it possible to deal with more realistic applications and facilitate the experimental approach that is emphasized. There is a synergy between writing and meaningful problems that engaged students on a high intellectual plane requiring them to understand and articulate the mathematics, the applications, and the connections between them.

Implementation of the Harvard Core Calculus at Stony Brook

Anthony V. Phillips, Dusa McDuff	DUE-9352843
SUNY Stony Brook	FY1993 $ 155,864
Stony Brook, NY 11794-0001	Calculus

The Harvard Consortium Curriculum is being implemented throughout the Calculus courses, from beginning through multivariate, in the context of a thorough revision of the first-year and remedial classes. This involves adapting the Harvard curriculum to meet the needs of a diverse student population, who fall into three categories: the 1600 students a year who take the first term of the Precalculus/Calculus sequence, for whom the precalculus end of the curriculum needs to be expanded; the 900 who take either the slow-stream or the mainstream Calculus, who can use the curriculum essentially in its present form, and a smaller number of well prepared students, who took some Calculus in high school, and would benefit from enrichment material to supplement the more routine sections of the curriculum. Undergraduate majors interested in secondary teaching are being recruited to participate in workshops and seminars offered as part of the project and to gain teaching experience in the revamped precalculus and calculus courses.

Development Site for Complex, Technology-Based Problems in Calculus

Brian J. Winkel, Roger Lautzenheiser, Bart Goddard	DUE-9352849
Rose-Hulman Institute of Technology	FY1993 $ 100,000
Terre Haute, IN 47803	Calculus

Faculty and students at the Rose-Hulman Institute of Technology in cooperation with several high school teachers are developing and disseminating complex problems in calculus. These calculus problems are based on applications in science and engineering and offer an opportunity to use computers as part of the problem-solving strategy. These technology-based problems are interdisciplinary in nature and integrate concepts from calculus, engineering and physics. During the academic year, faculty are locating resources and developing significant problems, testing them in courses, summarizing student reactions and solution strategies and modifying and extending problems. Student developers are assisting in evaluating solutions submitted by student solvers, assessing prerequisite knowledge needed for attempting these problems and determining the level of effort and time needed for success. In the summer, teams of faculty, students, and high school mathematics teachers are developing new problems, polishing established problems, preparing standard formats for problem presentation, loading the materials for electronic access through anonymous "ftp" site facilities (Bitnet and Internet) at Rose-Hulman, producing Mathematica resources to accompany problems, and writing up guidelines for using problems in high school and college calculus settings. Suggestions for non-Mathematica users are being offered in each situation as well as guides on how to use the materials. About 50 problem sets are being developed. Faculty from Rose-Hulman are conducting short courses in problem use and development at local, regional, and national meetings.

Mathematica Laboratory Projects for Calculus and Applied Mathematics

William H. Barker, Robert J. Knapp	DUE-9352868
Bowdoin College	FY1993 $ 77,871
Brunswick, ME 04011	Calculus

The project directors are designing and constructing Mathematica computer laboratory notebooks for calculus and applied mathematics. This builds on Bowdoin College's three years of experience as the Mathematica laboratory development site for Project CALC, the calculus reform program from Duke University. The primary focus of the development efforts is on applications from other disciplines which are new to the calculus and applied mathematics curriculum. The calculus laboratory development effort has multivariable calculus as a primary emphasis. The materials produced are being disseminated, and instructors using the laboratories are being supplied with training and ongoing support.

Dissemination of the laboratories and support of instructors using the materials is being accomplished by (1) a three-day summer faculty workshop entitled "Laboratory Instruction with Mathematica," (2) a dissemination network which includes distribution of Mathematica notebooks via FTP and disk mailings, (3) publications, and (4) presentations and workshops at regional and national meetings.

This project is adding Mathematica laboratory notebooks to the collection of materials currently available for revitalized courses in calculus and applied mathematics. These notebooks are distinguished by their complete development of topics under study, their focus on models from other disciplines, and their use of graphics routines to develop geometric understanding. Aggressive dissemination of the notebooks is encouraging the adoption of Mathematica into calculus and applied mathematics courses, providing students with a research-level tool which can be carried on to other courses in mathematics, the sciences, and economics.

The Western Pennsylvania Calculus Technology Consortium

Frank Beatrous, Juan Manfredi, Beverly K. Michael, Estela S. Llinas DUE-9352874
University of Pittsburgh FY1993 $ 144,443
Pittsburgh, PA 15260 Calculus

Technology enhanced calculus courses are being established at two campuses of the University of Pittsburgh. The approach adopted in the University courses is based on the Calculus and Mathematica (C&M) project developed at the University of Illinois by H. Porta and J. Uhl and at Ohio State University by W. Davis. Pilot courses using C&M have been taught at the University of Pittsburgh since the Spring of 1991. The CALC-TECH project will facilitate large scale implementation of the C&M project on the two University campuses. This requires workshops for faculty and graduate teaching assistants, development of materials, and evaluation.

Interactive Modules For Courses Following Calculus

Lawrence C. Moore, David A. Smith DUE-9352889
Duke University FY1993 $ 181,827
Durham, NC 27708 FY1994 $ 180,860
Calculus

The authors are developing interactive laboratory and classroom materials to support follow-up courses for students completing the reformed calculus course: linear algebra, differential equations and applied mathematical analysis. A seven-member development team, working at five different institutions over a two-year period, will develop approximately 70 interactive text modules. Each module will be developed in one of the systems Mathcad 3.1, Maple V, or Mathematica, and translated by student assistants to each of the other two systems.

This project will build on and reinforce the acquired concepts and shared experiences of students moving on from reformed calculus courses. These students know how to work in a lab, how to work with partners, and how to work on their own. Moreover, they have had introductions to many of the important ideas that will be developed further in the follow-on courses. Such students will find conventional courses less than satisfactory as preparation for their scientific or engineering careers in the 21st century. The modules to be developed by this project will enable students to work with significant and realistic problems in a modern computer environment that allows the to experiment to vary examples endlessly, and to control the order and pace of their learning.

Calculus For Comprehensive Universities and Two-Year Colleges

Gregory D. Foley, David K. Rueh	DUE-9352894
Sam Houston State University	FY1993 $ 70,000
Huntsville, TX 77341	Calculus

The goals of this fifteen-month project are to design and implement a curriculum for the critical first year of calculus at comprehensive universities and two-year colleges. The program adapts and synthesizes methods from successful calculus reform efforts and is crafted to meet local needs.

The curriculum stresses and facilitates cooperative learning, develops visual thinking with the aid of interactive graphing technology, and uses writing to help students learn and communicate mathematics. These methods are integrated in an environment that focuses on the central ideas of calculus and provides a progression of problems and projects to challenge students while improving their confidence and study skills.

The project establishes a collaborative partnership among Sam Houston State University, North Harris College, San Jacinto College Central, and Tomball College. Two faculty members from each of these four institutions will serve as site leaders. All eight site leaders will meet regularly to share ideas, experiences, and materials. A volume of student assignments will be compiled to serve as a resource for college faculty across the nation.

Maricopa Mathematics Consortium (M2C) Project

Alfredo G. de los Santos, Christian Ringhofer	DUE -9352897
Maricopa County CC District	FY1993 $ 100,00
Tempe, AZ 85281	Calculus

The Maricopa Mathematics Consortium (M2C)--composed of the Maricopa County Community College District, the second largest community college district in the country; Arizona State University, the fifth largest public university in the United States; and four public school districts in Maricopa County is instituting a two-year project that is resulting in significant systemic change in the teaching/learning process in precalculus mathematics: the bridge to calculus. The participating institutions, who serve 235,000 students, have a long history of cooperation and joint development. This collaborative effort includes restructuring the curriculum, developing materials to reflect the changes to be made, and using technology and new pedagogies. Faculty/staff development is being provided during all phases to build faculty support and confidence in these new approaches to teaching mathematics (776 faculty). During the evaluation process, they are examining outcomes at key benchmark points in the areas of faculty development, student learning, and developmental processes. A team of administrators, faculty, and staff are providing leadership and management to the project with support from key individuals who serve on the National Advisory Committee.

The Washington Center Calculus Dissemination Project

Robert S. Cole, Janet P. Ray	DUE-9352900
Evergreen State College	FY1993 $ 252,506
Olympia, WA 98505	Calculus

The "Washington Center for Improving the Quality of Undergraduate Education," is augmenting and extending for another two years the work of its "Washington Center Calculus Project". The goals for the project are to build sustainable institutional commitments to calculus reform efforts already initiated, to deepen understanding of assessment tools appropriate to some of the new pedagogies being used in teaching calculus, to increase the number of institutions using reform calculus curricula and to document the dissemination model they are using for statewide calculus reform. This proposal broadens the scope of the work in which they are currently engaged and focuses more upon sustaining and institutionalizing curricular reform, rather than initiating it, and upon developing and documenting assessment and dissemination methods appropriate to regional initiatives. Activities include assessment workshops, an Assessment Task Force with a seed grant program for assessment projects, curriculum workshops for faculty members, site visits, newsletters and follow-up workshops.

Differential Equations: A Dynamical Systems Approach

Paul R. Blanchard, Marvin I. Freedman, Glenn R. Hall,	DUE-9352833
Robert L. Deavany	FY1993 $ 117,260
Boston University	FY1994 $ 102,241
Boston, MA 02215	Calculus

A large-scale revision of the traditional sophomore-level ordinary differential equations course is being developed which emphasizes qualitative theory with a distinct dynamical systems orientation. A discussion of difference equations will precede the introduction of differential equations, the computer will be used to analyze solutions, and a more detailed discussion of nonlinear systems will be included. A consortium of colleges and universities will assist in developing the syllabus and materials, as well as serve as initial test sites for the textbook.

A Three Semester Integrated Calculus\Physics Sequence

Wesley Ostertag, Anthony Zito	DUE-9352841
SUNY Dutchess Community College	FY1993 $ 95,010
Poughkeepsie, NY 12601	Calculus

The investigators are writing laboratory materials for and team teaching an integrated three semester sequence of courses in calculus and physics. The sequence is covering the material normally developed during the first three semesters of the standard analytical calculus sequence and the standard engineering physics sequence taken by freshmen and sophomores.

The core of the project is the creation of a series of mini-labs which develop analytical topics in tandem with physical principles using data-gathering equipment connected to personal computers. The investigators are considering the long-standing pair of problems in introductory science education: applications meant to motivate the calculus are often developed poorly, and/or out of context by the calculus instructor; also, the mathematical tools needed in the physics course are often used by the physics instructor before they have been adequately developed in the calculus course.

Full-Scale Calculus Revitalization and Evaluation Project

Joe A. Marlin, Ernest E. Burniston, J.A. Danby	DUE-9352845
North Carolina State University	FY1993 $ 99,878
Raleigh, NC 27695-8208	Calculus

An experience-based, application-driven, two-year calculus sequence involving 50 faculty members, 50 graduate teaching assistants and over 4,000 undergraduate mathematics, science and engineering majors each semester is being developed. The three year plan includes revitalizing the undergraduate calculus curricula and instructional techniques through curriculum enhancement, experiential computer laboratories and intensive faculty development. The aim of the plan is to empower any capable and willing undergraduate student to succeed in calculus and differential equations and to encourage advanced study in applied mathematics. A team-based approach to curriculum and assessment development, involving faculty from client disciplines, is focusing on applications of mathematics and the use of technology to illustrate the central importance of calculus in engineering and science. The project demonstrates innovative adaptations of small-scale models previously developed by others; in addition it will develop a new set of curriculum enhancements emphasizing applications in other disciplines, which may be adopted or further adapted at institutions of any size.

Core Calculus Consortium: A Nationwide Project

Andrew Gleason, Debra Hughes-Hallet	DUE -8953923
Harvard University	FY 1993 $ 337,500
Cambridge, MA 02138	Calculus

A national consortium of institutions is developing an innovative core calculus curriculum that is practical and attractive to a multitude of institutions. The consortium is led by Harvard University and, in addition, consists of the University of Arizona, Colgate University, Haverford-Bryn Mawr Colleges, the University of Southern Mississippi, Stanford University, Suffolk Community College and Chelmsford High School. The refocus of calculus will use the "Rule of Three" whereby topics are explored graphically, numerically and analytically.

Workshops for Dissemination of Calculus Reform Projects

A. Wayne Roberts, Donald B. Small	DUE -9252529
Macalaster College	FY 1992 $ 165,515
Saint Paul, MN 55105	FY 1993 $ 168,520
	Calculus

Sixteen one week workshops, eight in the summer of 1993 and eight more in the summer of 1994, are being held at sites geographically distributed throughout the country. Each workshop has 24 participants from high schools, two and four year colleges, and universities. Workshop leaders will be drawn from the ranks of those who have led the reform movement. The leaders illustrate the use of the particular materials and methods they have developed and prepare participants for obstacles that confront curricular reform. Participants engage in the activities of a particular approach to reform, consider the criticisms that led to the calculus reform movement, be presented with a national overview of curricular reform, and be asked to reflect on the goals and expectations they bring to teaching the course. They will then be asked to consider their own situation and to formulate a plan for action in their home institutions.

NATIONAL SCIENCE FOUNDATION
DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES
UNDERGRADUATE COURSE AND CURRICULUM DEVELOPMENT PROGRAM
FY 1993 AWARDS

STATE INSTITUTION CITY NAME AWARD TITLE	PROJECT DIRECTOR ZIP	DISCIPLINE DEPARTMENT	AWARD AMOUNT	GRANT DURATION (MOS)	GRANT NUMBER
ALABAMA					
Talladega College Talladega Using Computers to Challenge High Aptitude Intellect/Stimulate Creativity	C M Stinson 35160	Chemistry Chemistry	$63,750	36	9254015
U of Alabama Tuscaloosa Tuscaloosa Addressing Software Development Skills in a Curriculum Focusing on the Science of Computing	D Cordes 354872856	Computer Science & Engi Department of Computer Science	$40,241	12	9254116
ARIZONA					
Mesa Cmty College District Flagstaff Computer Applications to Enhance Inquiry-Oriented Laboratory Instruction in Biology at a 2-Year College	W B Kincaid 860023349	Life Science Biological Dept of Life Science	$132,180	12	9254228
Northern Arizona Univ Flagstaff A Slice of Life: An Introductory Biology Course	D Ebert-May 86011	Life Science Biological Biological Sciences and Science	$303,145	38	9254280
CALIFORNIA					
Amer Math Assoc Two Yr Col Santa Rosa Curriculum and Pedagogy Reform at Two-Year Colleges: Moving Beyond Myths to Standards	M E Mays 95401	Mathematics Humanities/Mathematics/Technol	$80,515	12	9255850
Cal Poly St SanLuis Obispo San Luis Obispo Physics for the Year 2000	R D Knight 93407	Physics Physics	$55,000	12	9346869
Cal State Poly Univ Pomona Pomona Integrated-Science General Education Using a Hybrid Interdisciplinary Teaching Methodology	L R Troncale 91768	Interdisciplinary Institute for Advanced Systems	$99,999	15	9254119
Cal State U Fresno Fresno Scientific Visualization	T K Alameldin 93740	Computer Science & Engi Dept. of Architecture	$94,776	24	9254357
Humboldt State University Arcata Visualization of the Abstract in General Chemistry	R A Paselk 95521	Chemistry Dept of Chemistry	$103,984	12	9346870
Mission College Santa Clara Designing a Portable Technical Literacy Course for Use in California	K Disney 95054	Engineering Engineering	$34,884	12	9254172

BEST COPY AVAILABLE

Occidental College E Braker Science and Humanities $73,000 12 EW-20152
Los Angeles 90041 Dept. of Biology
The Borders: A Multidisciplinary Approach to Critical Issues

Santa Clara University S L Wood Engineering-Electrical $88,154 24 9346874
Santa Clara 95053 Engineering
Interactive Tutorial for Engineering Mathematics with Applications in Electrical and Computer Engineering

U of Cal Santa Barbara W A Prothero Geological Sciences $105,641 18 9254192
Santa Barbara 93106 Geological Sciences
Computer Based Media and Lab Exercises for a Lower Division Oceanography Course

COLORADO

U of Colorado Boulder H H Covert Social Sciences $160,468 36 9254227
Boulder 80309 Anthropology
Enhancing Undergraduate Learning in Natural Science: A New Curriculum for Laboratory Classes in Biological Anthropology

CONNECTICUT

Southern CT State College T W Bynum Computer Science & Engi $56,488 12 9224159
New Haven 06515 Dept. of Computer Science
Multimedia Courseware on Computing and Human Values

DISTRICT OF COLUMBIA

Amer Soc For Microbiology S L Zablotney Life Science Biological $8,820 6 9353342
Washington 20006 College of Graduate Studies
Conference on "Strategies for Teaching the Life Sciences to Undergraduates"

Conf Bd of the Math Sci R C Rosier Mathematics $5,200 12 9353210
Washington 20036
Invited Foundational Papers on Research in Undergraduate Mathematics Education

Georgetown University J G Chirikjian Life Science Biological $15,000 24 9371016
Washington 20057 Dept of Biochemistry & Molecul
Undergraduate Biotechnology Curriculum Development Project

Math Assn of America D J Albers Mathematics $50,000 12 9255393
Washington 200010000
Math Horizons

Nat Acad of Sciences G E Dwoskin Mathematics $20,000 15 9345948
Washington 20418
Mathematical Sciences: Modern Interdisciplinary University Statistics Education

FLORIDA

Fl Cmty Col Jacksonville C C Bailey Interdisciplinary $78,000 15 9253963
Jacksonville 322024030 Natural Sciences
Improving Science and Mathematic Education through Integrated Content and Interactive Discovery Learning

GEORGIA

GA Tech Res Corp - GIT G J Thuesen Engineering $180,983 24 9346867
Atlanta 30332 Sch of Industrial & Systems En
The Integration of Economic Principles with Design in the Engineering Science Component of the Undergraduate Curriculum

IDAHO

University of Idaho	Moscow	T E Bitterwolf	83843	Interdisciplinary	Department of Chemistry	$207,597	12	9254158	Integrated Science for Elementary Teachers: A Course and Practicum Approach to Restructuring Undergraduate Science Preparation for Teachers

ILLINOIS

Amer Soc of Zoologists	Chicago	M Morse	60680	Life Science Biological	Marine Science Center/Biology	$20,000	6	9340004	Symposium: Science as a Way of Knowing: Biodiversity; to be held December 27-30, 1992 in Vancouver, B.C.
DePaul University	Chicago	C C Narasimhan	60604	Interdisciplinary	Mathematics	$124,545	24	9254323	Connecting Science and Mathematics: An Integrated Program for Undergraduates

INDIANA

Indiana U Bloomington	Bloomington	R R Hake	47402	Physics	Physics	$104,149	36	9253965	PROJECT SOCRATES; Improving Introductory Physics Education Through Interactive Engagement
Purdue University	West Lafayette	C M Krousgrill	479071288	Engineering-Mechanical	School of Mechanical En	$79,999	12	9254129	A Creative Approach to Teaching Undergraduate Mechanics Emphasizing Development of Instructional Tools to Enhance Spatial Visualization and Inductive Learning

IOWA

Iowa State University	Ames	T J Greenbowe	50011	Chemistry	Chemistry	$88,078	12	9253985	Interactivity Chemistry Experiments: A Multimedia Approach

KENTUCKY

Eastern Kentucky Univ	Richmond	B MacLaren	40475	Interdisciplinary	Natural Science	$120,000	30	9254153	Cosmos and Evolution: An Exploration of Nature
Eastern Kentucky Univ	Richmond	B J Gray	40475	Science and Humanities		$178,200	24	EW-20125	Integrating for Excellence: Linking Science and Humanities Honors Courses

LOUISIANA

Louisiana Tech University	Ruston	B L Kurtz	71272	Computer Science & Engi	Dept of Computer Science	$101,833	18	9254317	An Interdisciplinary , Laboratory-Oriented Courses Sequence for Computer-Based Problem Solving
U of Southwestrn Louisiana	Lafayette	M C Mulder	70504	Engineering	Cntr for Advanced Computer Stu	$20,480	12	9352944	A Multi-disciplined Task Force to Develop Framework for an Information Science and Engineering Discipline

MAINE

Bowdoin College	Brunswick	C R Phillips	04011	Life Science Biological	Biology	$125,000	24	9254263	Using a Hypermedia System to Integrate 3-D Animations into an Introductory Biology Text

MARYLAND

Howard Community College	Columbia	21044	D Friedman	Interdisciplinary	Dept. of Science	$149,976	24	9346871	Fostering Computational Problem-Solving Skills in Introductory Sciences: An Interactive Multimedia Curriculum

MASSACHUSETTS

Boston College Univ	Chestnut Hill	02167	R Cobb-Stevens	Science and Humanities	Dept. of Philosophy	$90,000	24	EW-20105	New Perspectives: Humanities and Sciences
Brandeis University	Waltham	02254	M Henchman	Chemistry	Department of Chemistry	$69,117	12	9254291	Developing a Science Course for Non-Scientists on the Chemistry of Art
Clark University	Worcester	01610	S Blatt	Physics	Physics	$240,000	24	9254222	Devleopment of a Discovery Approach for an Introductory Level Physics Course
Harvard University	Cambridge	02138	E Mazur	Physics	Applied Sciences	$100,000	12	9254027	Peer Instruction: Stimulating Renewed Interest in Physics and Other Science and Engineering Courses
Holy Cross College	Worcester	01610	R W Ricci	Chemistry	Chemistry	$143,000	24	9254016	Instructor's Reference Manual for Discovery Chemistry
Holyoke Cmty College	Holyoke	01040	D Ram	Science and Humanities	Dept. of English	$106,954	36	EW-20134	Learning Communities in Humanities, Social Sciences & Natural Science
Tufts University	Medford	02155	R K Thornton	Physics	Center for Science/Mathematics	$230,000	12	9346861	Student Oriented Science: Curricula, Techniques and Computer Tools for Interactive Learning
U of Massachusetts Boston	Boston	02125	L A Kime	Mathematics	Mathematics and Computer Scien	$206,097	30	9254117	A Redesign of the College Algebra Course
Worcester Polytech Inst	Worcester	01609	J D Petruccelli	Mathematics	Mathematical Sciences	$165,000	24	9254087	A Modular Laboratory and Project-Based Statistics Curriculum

MICHIGAN

Grand Valley State Univ	Allendale	49401	A M Champion	Mathematics	Mathematics	$81,550	15	9254046	The Multicultural Mathematics Project
Mich Technological Univ	Houghton	49931	B J Gimmestad	Engineering	Mathematical Sciences	$80,000	24	9254207	A Course for the Development of 3-D Spatial Visualization Skills in Freshman Engineering Students
Oakland University	Rochester	483094401	R L Tracy	Mathematics	Economics	$60,029	24	9254182	Realizing the Power of Computers in Business Statistics Instruction: A Next Step
U of Michigan Ann Arbor	Ann Arbor	481091220	H Fogler	Engineering	Chemical Engineering	$93,503	6	9254354	Focus on Interactive Problem Solving in a First-Year Engineering Course

MINNESOTA

U of Minnesota-Twin Cities	F N Finley	Geology	$63,266	24	9345983
Minneapolis	55415	Dept. of Geology			
Interactive Earth Systems - A Curriculum and Course Development					

MISSOURI

U of Missouri Rolla	R A Behr	Engineering-Civil	$5,000	30	9347217
Rolla	65401	Dept of Civil Engineering			
ANEX/RIED: Analysis, Experiment and Engineering Drawings in a Portable Structural Model Laboratory					
U of Missouri Saint Louis	S K Feigenbaum	Social Sciences	$90,612	24	9254299
Saint Louis	63121	Econommics			
Introductory Microeconomics: The Way We Live					

NEBRASKA

Doane College	D H Smith	Chemistry	$99,457	36	9254245
Crete	68333	Chemistry			
Devising a More Effective Approach to the Study of General Chemistry					

NEVADA

U of Nevada Reno	C P Gupta	Mathematics	$50,000	12	9254243
Reno	89557	Department of Mathematics			
Faculty Development in Mathematics: A Model for Enhancing Math Skills Throughout the Core Curriculum					

NEW HAMPSHIRE

Dartmouth College	R M Green	Science and Humanities	$95,000	36	EW-20122
Hanover	037553500	Philosophy of Religion			
Making Babies: The Scientific, Ethical & Social Challenge of Assisted Reproduction					

NEW JERSEY

NJIT	F A Dolan	Engineering	$92,000	12	9254293
Newark	07102	Manufacturing Systems			
Curriculum Development - Manufacturing Systems					
Princeton University	D P Billington	Engineering-Metallurgy	$25,000	24	9347012
Princeton	08544	Dept of Civil Eng. & Operation			
Engineering and Modern Society: A Freshman Course					
Rutgers U Busch Campus	G K Horton	Physics	$263,940	24	9254247
Piscataway	088541089	Department of Physics and Astr			
Establishment of Extended General Physics - An Alternative Course for Underprepared Students					
Rutgers U Newark Campus	D E Murnick	Physics	$157,594	12	9346865
Newark	07102	Department of Physics and Astr			
Innovative Introductory Physics Laboratory Course					
Trenton State College	E Conjura	Computer Science & Engi	$78,604	12	9254109
Trenton	08625	Dept. of Computer Science			
An Integrated Approach to Teaching the Languages of Programming and Mathematics in the Computer Science Curriculum					
Trenton State College	M E Winston	Science and Humanities	$55,382	18	EW-20180
Trenton	086504700	Philosophy and Religion Dept.			
Society, Ethics, and Technology					

NEW MEXICO

New Mexico St University	Las Cruces	88003	B J McNamara	Astronomy	Department of Astronomy	$34,000	12	9253979	Astronomy and Writing: An Innovative Approach to Science Instruction
New Mexico St University	Las Cruces	88003	A F Burr	Physics	Department of Physics	$150,610	24	9254369	Cost Effective Laboratory for a Large General Education Physics Course
New Mexico St University	Las Cruces	88003	A Van Heuvelen	Physics	Department of Physics	$140,000	12	9396205	Active Construction and Application of Conceptual Models
University of New Mexico	Albuquerque	87131	M Zeilik	Astronomy	Department of Physics & Astron	$65,831	24	9253983	Conceptual Astronomy: A Process Oriented Course

NEW YORK

Alfred University	Alfred	14802	M M Hluchy	Life Science Biological	Department of Geology	$73,638	36	9254104	Introductory Course to Teach Methods in Environmental Science
Amer Inst of Physics	New York	10017	L A Coleman	Physics		$50,252	12	9346862	Introductory University Physics Project (IUPP) - Phase III
Colgate University	Hamilton	13346	C H Nevison	Computer Science & Engi		$70,100	12	9345984	Undergraduate Parallel Computing Curriculum Development II
Columbia University	New York	10027	E Galanter	Interdisciplinary	Dept of Psychology	$100,573	6	9253980	The Quantitative and Experimental Study of Human Nature
Cornell University	Ithaca	276958208	P F Velleman	Mathematics	Econ. and Social Statistics	$76,716	36	9346881	Technology-Based Learning: Exploring Statistical Concepts and Methods
Cornell University	Ithaca	148532501	S S Jasanoff	Science and Humanities	Dept of Science & Technology Studies	$109,565	36	EW-20121	Curriculum Development in Science & Technology Studies
CUNY B Baruch College	New York	10010	N Fainstein	Science and Humanities	Dept of Political Science	$235,000	36	EW-20113	Darwin and Darwinism: Scientific Theory and Social Construction
CUNY H H Lehman College	Bronx	10458	J D Ullman	Interdisciplinary	Physics & Astronomy	$172,858	24	9254178	An Inquiry-Discovery of Elementary Mathematics/Science Courses with a Teacher Training Component
CUNY Queensboro Cmty Col	New York	11364	B E Mohr	Engineering-Electrical	Dept. of Electrical & Computer	$303,395	30	9254187	Mastery of Engineering Technology
New York University	New York	10012	F P Greenleaf	Interdisciplinary	Mathematics	$357,190	36	9254301	Large-Scale Science Core Program for the Non-Science Student
Rensselaer Polytech Inst	Troy	121803590	J M Wilson	Interdisciplinary	Dept. of Physics	$28,838	12	9350168	Conference on the Introductory Physics Course

Rensselaer Polytech Inst	J M Wilson	Physics	$160,451	12	9346878
Troy	121803590	Dept. of Physics			
CUPLE: The Comprehensive Unified Physics Learning Environment					
Rensselaer Polytech Inst	H W McLaughlin	Interdisciplinary	$160,100	24	9346879
Troy	121803590				
Computing Across the Basic Sciences					
Rochester Institute of Tec	K Donaghy	Computer Science & Engi	$77,940	24	9254160
Rochester	14623	Information Technology			
Development of an Undergraduate Major in Information Technology					
Saint Lawrence University	K E Johnson	Interdisciplinary	$8,974	24	9254056
Canton	13617	Physics			
Science is a Liberal Art at St. Lawrence University					
SUNY Buffalo	D S Hodge	Geological Sciences	$173,970	18	9254211
Buffalo	14214	Geological Sciences			
Acquisition, Analysis and Visualization Approach to Introductory Geological/Environmental Laboratory					
SUNY Dutchess Cmty College	J Tavel	Interdisciplinary	$115,000	24	9254184
Poughkeepsie	12601	Math, Physical & Computer Scie			
Basics for Technicians: An Integrated Course of Study Encompassing Mathematics, Chemistry, and Physics					
SUNY Fashion Inst of Tech	C Johnson	Mathematics	$70,780	12	9254120
New York	10001	Science and Math			
Geometry and the Art of Design					
SUNY Geneseo	G W Scragg	Computer Science & Engi	$83,919	18	9254252
Geneseo	14454	Dept. of Computer Science			
Gateway Labs for a Problem Solving Course					
SUNY Nassau Cmty College	R K Berenson	Interdisciplinary	$55,192	24	9346877
Garden City	11530	Engineering and Physics			
Improving Scientific Literacy of Undergraduate Students through "Hands-On" Multidisciplinary Science					
SUNY Potsdam	J T Omohundro	Science and Humanities	$109,565	12	EW-20174
Potsdam	13676	Dept of Anthropology			
The Adirondacks: An Interdisciplinary Coordinated Studies Program in Environmental Studies					
SUNY Stonybrook	P B Henderson	Computer Science & Engi	$115,001	18	9254084
Stony Brook	117940001	Computer Science			
Mathematical Foundations of Computer Science					
SUNY Stonybrook	R K Larson	Social Sciences	$32,667	12	9346860
Stony Brook	117940001	Dept. of Linguistics			
Linguistics Semantics as Science					
SUNY Suffolk County CC	S P Gordon	Mathematics	$149,917	24	9254085
Selden	11784	Mathematics			
Filling the Tank: The Math Modeling/PreCalculus Reform Project					
SUNY Tech Delhi	D Callas	Mathematics	$63,000	18	9254326
Delhi	137531190	Mathematics and Science			
Snapshots of Applications in Mathematics					

NORTH CAROLINA

Barber-Scotia College	M Medlin	Social Sciences	$195,658	36	9254191
Concord	28025	Social Sciences			
Introductory Anthropology for Historically Black Colleges					

BEST COPY AVAILABLE

Duke University Durham	N L Christensen 27708	Life Science Biological School of the Environment	$116,473	24	9346873
Environmental Science and Policy: An Introductory Sequence					
East Carolina University Greenville	D Lunney 278584353	Chemistry Department of Chemistry	$171,713	36	9254330
Development of a Data Acquisition and Data Analysis System for Visually Impaired Chemistry Students					
U of NC Greensboro Greensboro	G W Meisner 21412	Physics Dept. of Physics	$127,626	12	9346876
Physics and the 3 Rs: Recruit, Restructure and Retain.					

OHIO

Ohio State Univ Res Fdn Columbus	W I Notz 432101063	Mathematics Mathematics	$167,000	12	9346880
Technology-Based Learning: Exploring Statistical Concepts and Methods					

OKLAHOMA

University of Oklahoma Norman	G A Mitman 73019	Science and Humanities History of Science Dept.	$157,000	24	EW-20153
Conceiving the Commons: An Interdisciplinary Approach to Environmental Literacy					

OREGON

Oregon State University Corvallis	J A Gardner 973315503	Mathematics Physics	$5,000	12	9220322
New Technologies for the Blind: Improving Accessibility to Science					
Portland State University Portland	W G Becker 97207	Interdisciplinary University Honors Program	$181,749	24	9253973
Science in the Liberal Arts Education: An Undergraduate Course Development Project					

PENNSYLVANIA

Allegheny College Meadville	G G Wurst 16335	Life Science Biological Department of Biology	$101,010	36	9254168
Improving Introductory Biology Laboratories at Allegheny College Through the Development and Implementation of Computer-Based Modules					
Carlow College Pittsburgh	C A Zalewsky 15213	Life Science Biological Biology	$119,622	24	9254215
Science and Language: A Transitional and Integrative Approach to the Learning of Science					
Carnegie-Mellon University Pittsgurg	B A Sherwood 15213	Physics Dept of Physics	$71,990	12	9346875
Electrical Interactions and the Structure of Matter: Qualitative					
Drexel University Philadelphia	W E Magee 19104	Life Science Biological Bioscience and Biotechnology	$269,266	48	9253994
An Enhanced Bioscience Education Program for the Introductory Years of the Biology Major and for Interested Preteachers					
Drexel University Philadelphia	J L Popyack 19104	Computer Science & Engi Dept of Mathematics & Computer	$25,000	18	9254013
The Innovative Use of Software in Introductory Computer Programming					
Franklin and Marshall College Lancaster	E S Reed 17604	Science and Humanities Dept. of Psychology	$62,837	24	EW-20126
The Study of Mind Program: An Interdisciplinary Major					

Gettysburg College	L A Marschall	Astronomy	$130,880	12	9346868
Gettysburg	17325	Dept of Physics			
Modernizing the Introductory Astronomy Laboratory					
PA St U University Park	L J Waks	Interdisciplinary	$125,533	15	9254108
University Park	16801	Science, Technology, and Socie			
Critical Issues in Science, Technology and Society, An Integrated Course Sequence					
Susquehanna University	P A Nelson	Science and Humanities	$42,644	24	EW-20176
Selinsgrove	17870	Dept. of Education			
Integrated Course in Science and Humanities					
Theil College	G R Khalsa	Science and Humanities	$135,000	36	EW-20179
Greenville	16125	Dept. of Chemistry			
Global Heritage: A Multidisciplinary Focus on Sustainable Development					
U of Pittsburgh	L J Shuman	Engineering	$209,999	27	9254271
Pittsburgh	15260	School of Engineering			
The Freshman Engineering Experience					

RHODE ISLAND

Brown University	T F Banchoff	Mathematics	$99,787	24	9254322
Providence	02912	Dept. of Mathematics			
A Laboratory Approach to Introductory Differential Geometry					

SOUTH CAROLINA

Francis Marion University	G Hanson	Social Sciences	$73,387	24	9245525
Florence	295010547	Psychology			
Devopment and Implememtation of Introductory Labs in Psychology					

TEXAS

Baylor University	D A Adams	Life Science Biological	$262,433	27	9254171
Waco	767987334	Biology			
Design and Implementation of a Bioliteracy Laboratory Course to Replace Traditional Introductory Non-Majors Biology Laboratories at Colleges and Universities					
U of Texas Austin	M J Gonzalez	Engineering-Electrical	$156,469	18	9346398
Austin	78712	Electrical Engineering			
Course Development: Introduction to Electrical and Computer Engineering					
U of Texas Austin	P S Schmidt	Engineering-Mechanical	$105,984	6	9254005
Austin	78712	Mechanical Engineering			
Video Resources for Instruction in Introductory Engineering Thermodynamics					
U of Texas El Paso	J C McClure	Engineering-Metallurgy	$99,572	18	9254360
El Paso	79968	Metallurgy & Materials Enginee			
A Non-traditional Classroom for Engineering Materials Instruction Integrated with Teacher Preparation Activities					
U of Texas San Antonio	B S Travis	Mathematics	$79,946	23	9254165
San Antonio	78285	Mathematics/Computer Sci/Stati			
Mathematics Improvement Project for Underrepresented Students					
University of North Texas	K M Swigger	Computer Science & Engi	$139,710	18	9254068
Denton	76203	Computer Science Dept.			
Using a Computer-Supported Cooperative Problem Solving Environment to Teach Undergraduate Computer Science Students Cooperative Skills and Requirements Elicitation					

UTAH

Utah State University	V H Allan	Computer Science & Engi	$74,993	24	9254186
Logan	84322	Computer Science			
A Preparatory Course for Computer Science					

VIRGINIA

Hollins College	A M Frazier	Science and Humanities	$63,574	18	EW-20133
Roanoke	24020	Philosophy and Religion			
Core Seminars in Environmental Studies					
Lord Fairfax Cmty College	W R Warren	Physics	$30,649	24	9254094
Middletown	22645	Physics			
A Combined Calculus-Based/Non-Calculus Introductory Physics Course Using The Workshop Physics System					
University of Virginia	W A Wulf	Computer Science & Engi	$200,334	12	9346808
Charlottsville	22901				
Development of a set of "Closed Laboratories" for an Undergraduate					
Virginia Polytechnic Inst	S E Scheckler	Life Science Biological	$99,986	12	9254295
Blacksburg	24061	Biology			
Development & Assessment of a Multimedia Plant Science Laboratory					

WASHINGTON

U of Puget Sound	T A Cooney	Science and Humanities	$143,915	18	EW-20159
Tacoma	98416	American History			
"Science In Context" Seminars					
U of Washington	B Grunbaum	Mathematics	$10,000	12	9300657
Seattle	98195	Mathematics			
Mathematical Sciences: Geometry of Configurations, Polygons and Polyhedra					
U of Washington	J W Green	Social Sciences	$73,730	24	9254045
Seattle	98195	Dept. of Anthropology DH-05			
Anthropology Curriculum for Human Prehistory					

WISCONSIN

Beloit College	J Jungck	Life Science Biological	$52,551	24	9346866
Beloit	53511	Biology			
The BioQUEST Learning Tools Project					
U of Wisconsin Madison	A B Ellis	Chemistry	$700,000	30	9254107
Madison	53706	Department of Chemistry			
Development of a Materials-Oriented General Chemistry Course					
U of Wisconsin River Falls	M S Bergland	Life Science Biological	$47,927	24	9254089
River Falls	54022	Biology			
Interactive Hypermedia Experimental Simulations for Introductory Biology and Cell Biology Students					
U of Wisconsin Stevens	J P Droske	Chemistry	$170,323	18	9254351
Stevens Point	54481	Department of Chemistry			
Incorporating Polymeric Materials Topics in the Undergraduate Chemistry Core Curriculum: A Renewal and Extension					

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UNDERGRADUATE COURSE AND CURRICULUM DEVELOPMENT PROGRAM -- FY 1993
AWARDS
CALCULUS AND THE BRIDGE TO CALCULUS

STATE INSTITUTION CITY NAME AWARD TITLE	PROJECT DIRECTOR ZIP	DISCIPLINE DEPARTMENT	AWARD AMOUNT	GRANT DURATION (MOS)	GRANT NUMBER
ARIZONA					
Maricopa County CC Distri Tempe Maricopa Mathematics Consortium (M2C) Project	A G de los Santos 85281	Calculus Educational Development	$100,000	24	9352897
University of Arizona Tucson Implementation and Dissemination of the Harvard Consortium Materials in Arizona, Oklahoma and Utah	D Lovelock 85721	Calculus Mathematics	$301,809	12	9346887
CONNECTICUT					
Univ of Connecticut Storrs Integration of Computing into Main-Track Calculus	J F Hurley 06269	Calculus Mathematics	$197,064	12	9346882
DISTRICT OF COLUMBIA					
Howard University Washington Mid-Atlantic Regional Calculus Consortium	J A Leslie 20059	Calculus Mathematics	$100,000	12	9353137
GEORGIA					
GA Tech Res Corp - GIT Alanta The Georgia Tech-Clemson Consortium for Undergraduate Mathematics in Science and Engineering	A D Andrew 30332	Calculus Mathematics	$24,417	12	9346863
ILLINOIS					
U of Illinois Urbana Urbana Preparing for a New Calculus	A L Peressini 61801	Calculus Mathematics	$150,000	12	9346883
INDIANA					
Rose-Hulman Inst of Tech Terre Haute Development Site for Complex, Technology-Based Problems in Calculus	J B Winkel 47803	Calculus Mathematics	$100,000	30	9352849
IOWA					
University of Iowa Iowa City Fully Renewed Calculus at Three Large Universities	K D Stroyan 52242	Calculus Mathematics	$39,751	12	9346884

KENTUCKY

University of Kentucky	J H Wells	Calculus	$324,081	12	9346885
Lexington	405060057	Mathematics			
Implementing Calculus Reform in West Appalachia					

MAINE

Bowdoin College	W H Barker	Calculus	$77,871	24	9352868
Brunswick	04011	Mathematics			
Mathematics Laboratory Projects for Calculus and Applied Mathematics					

MASSACHUSETTS

Boston University	P R Blanchard	Calculus	$117,260	36	9352833
Boston	02215	Mathematics			
Differential Equations: A Dynamical Systems Approach					
Harvard University	A M Gleason	Calculus	$337,500	12	9346858
Cambridge	02138	Mathematics			
Core Calculus Consortium: A Nationwide Project					
U of Massachusetts Amhers	F Wattenberg	Calculus	$80,000	24	9352828
Amherst	01003	Mathematics & Statistics			
Calculus, Linear Algebra, and ODE's in a Real and Complex World					

MINNESOTA

Macalester College	A Roberts	Calculus	$101,066	12	9346888
Saint Paul	55105	Mathematics & Computer Science			
Workshop Program for Dissemination of Calculus Reform Projects					

MICHIGAN

U of Michigan Ann Arbor	M Brown	Calculus	$125,000	12	9346886
Ann Arbor	48109	Mathematics			
A New Calculus Program at the University of Michigan					

NEW YORK

SUNY at Stony Brook	A V Phillips	Calculus	$155,864	36	9352843
Stony Brook	11794	Mathematics			
Implementation of the Harvard Core Calculus at Stony Brook					
SUNY Dutchess Cmty College	W Ostertag	Calculus	$95,010	30	9352841
Poughkeepsie	12601	Math, Physics & Computer Science			
A Three Semester Integrated Calculus/Physics Sequence					

NORTH CAROLINA

Duke University	L C Moore	Calculus	$181,827	12	9352889
Durham	27708	Mathematics			
Interactive Modules For Courses Following Calculus					
North Carolina State U	J A Marlin	Calculus	$99,828	24	9352845
Raleigh	27695	Mathematics			
Full-Scale Calculus Revitalization and Evaluation Project					

PENNSYLVANIA

University of Pennsylvania	D M DeTurek	Calculus	$100,000	18	9352824
Philadelphia	19104	Mathematics			
Large-scale Calculus Revision at Penn					

U of Pittsburgh F Beatrous Calculus $144,443 36 9352874
Pittsburgh 15260 Mathematics and Statistics
The Western Pennsylvania Calculus Technology Consortium

TEXAS

Sam Houston St University G D Foley Calculus $70,000 24 9352894
Huntsville 77341 Mathematics
Calculus For Comprehensive Universities and Two-Year Colleges

UTAH

Brigham Young University G S Gill Calculus $32,225 12 9346890
Provo 84602 Mathematics
Fully Renewed Calculus at Three Large Universities

WASHINGTON

Evergreen State College R S Cole Calculus $252,506 27 9352900
Olympia 98505 Physics
The Washington Center Calculus Dissemination Project

WISCONSIN

U of Wisconsin La Crosse J Unbehaun Calculus $30,178 12 9346889
La Crosse 54601 Mathematics
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[1] All individuals listed contributed to the Course and Curriculum Program as well as the other programs in the Division. *These individuals contributed to FY93 Program but are no longer in the Division.

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When connected, press *Enter*. At the login prompt, enter *public*.

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Phone: (703) 306-0214 (voice mail)

TDD: (703) 306-0090

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